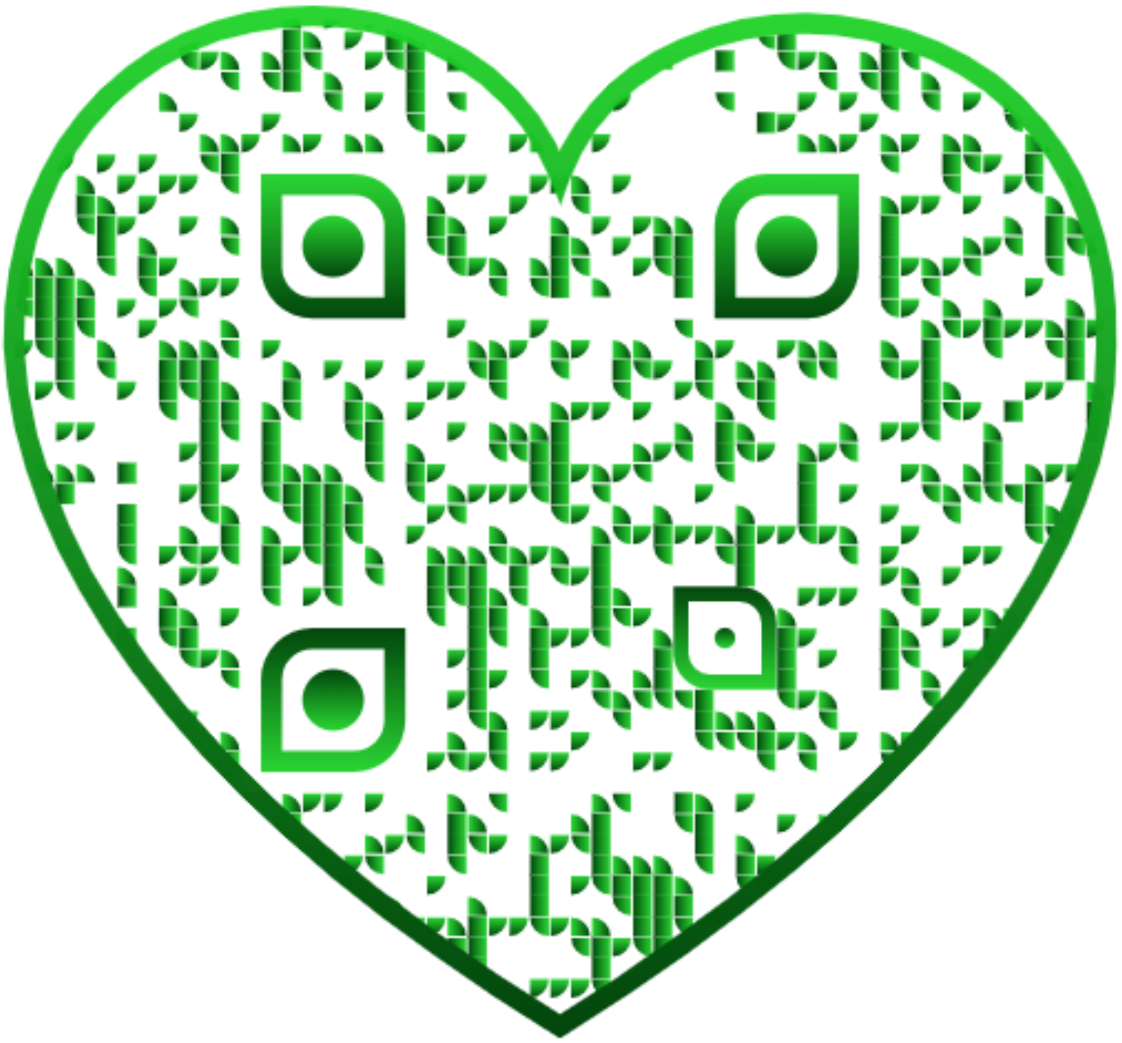
CNS LAB.



بسم الله الرحمن الرحيم

الحمد لله الذي بنعمته وفضله تتم الصالحات وعلى خاتم أنبياءه ورسله خيروأتم الصلوات ، أما بعد:

نشكر دكاترتنا الأفاضل وكل من كان له دور وبذل الجهد ليصل هذا العمل إلى ما وصل إليه.

يحتوي هذا الملخص على جميع ما شرحه الدكتور محمد عبد المغني و الدكتورة رهام النويرة في معامل الفسيو (CNS) ـ للمجموعات: الأولى ، الثانية والسابعة (دفعة 35) ـ مفصلاً و مرفقاً بالرسوم التوضيحية.

هذا العمل هو اجتهاد طلابي بحت وقد لايخلو من أخطاء غير مقصودة.

Neurological examination

Mental status;

1. Consciousness;

State of awareness and responsiveness. Its center is in the (RAS; reticular activity (arousal) system).

Many terms are used to describe the level of consciousness of the person like;

A) ***Fully conscious;*** normal.

B) ***Lethargic;*** the patient has severe drowsiness in which the patient can be aroused (awaken) by moderate stimuli and then drift back to sleep.

C) ***Stupor (light come);*** only vigorous (strong) and repeated stimuli will arouse the individual, and when left undisturbed, the patient will immediately lapse back to the unresponsive state.

D) ***Coma (deep);*** state of unarousable and unresponsiveness.

AVPU;

A; alert; fully conscious.

V; responds to voice; lethargy.

P; responds to pain; stupor.

U; unresponsive; coma.

2. Orientation (place-time-people);

- Ask the patient about the date and the place he is in at the moment.
- Ask him about his name or any person beside him he knows.

(He should know them to be normal regarding the orientation).

3. Memory;

It's controlled in the limbic system and the temporal region.

Types of memory;

Immediate- Recent (short term)- Long term (remote).

To test the immediate memory; ask the patient to repeat a sequence of numbers. The sequence must be at least composed of 7 digits.

To test the recent memory; ask the patient to memorize three unrelated words. Ex; (girl, ball, before) and till him that you will ask him about them later, so distract the patient for 5 minutes (usually by performing other part of the exam or you can talk with him about anything else). Then ask to recall the three words.

To test the long term memory (remote); ask the patient about events he lived of the past few weeks or ask him for the name of the presidents or common historical events.

Defects in memory (Amnesia) may be;

Retrograde;
- If the patient forgot the old events.
- Abnormal remote memory usually due to trauma.

Anti-grade;
- Defect in the immediate or recent (short term) memories.

4. Mood and affect;

Controlled by the limbic system and the temporal bone.

- Mood→ the patient's inner feeling.
- Affect→ outward expression of emotion.

Abnormalities;

Euphoria; false sensation of happiness.

The patient shows happiness (affect) but the environment around him doesn't interpret this sensation.

Emotional lability; sad, happy, sad again crying …

Apathy or indifferences; shows no reaction with any event.

5. Intelligence;

- Through IQ test which detects accurately the level of intelligence.

Or the person can be considered as (average intelligent) if he understands the doctor.

6. Behavior, presence of hallucination, illusion and delusion;

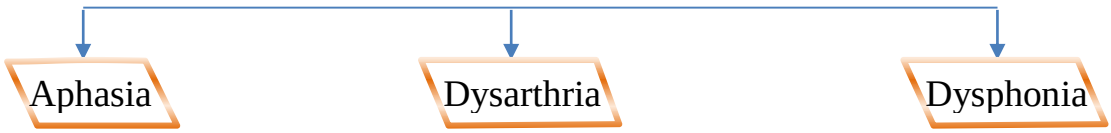
- **Behavior;** note how he sits, how he speaks, is he cooperative with you or not.
- **Hallucination;** sensation without any external stimulus, which may be visual, auditory, olfactory or tactile, i.e seeing, smelling, hearing things which do not exist at all.
  Note; some drugs cause hallucination.
- **Illusion;** misinterpretation of external stimulus i.e sensation and interpretation of a stimulus wrongly.
  Note; in compare to hallucinations, the stimulus is present.

Delusion; false fixed belief not shared by others, ex;

- Delusion of grandiosity; the patient believes that he is an important, famous, or international personality while he is not.
- Delusion of inferiority; the patient believes that he is nothing.

Examination of speech;

The main speech disorders;



Usually (dysphonia) is not included within speech neurological disorders.

Aphasia;

- Inability to formulate speech. It has two main types; motor and sensory.
- May be due to problems or lesions in the pathway between the areas associated with speech and language comprehension (in the cortex) which are;

1. (41,42) areas; primary auditory cortex.
2. (22) area; Wernicke's area (language comprehension).
3. (37) area; in occipitotemporal areas.
4. (44.45) areas: Broca's area (motor speech programming).
5. (4) area; primary motor cortex (tongue movement).

Sensory aphasia (fluent);

- The problem is in comprehension.
- The patient can see the words and alphabet but can't understand like it's a new language → (visual agnosia) problems or lesions in (18,19) areas.

Or

- The patient can hear the speech but can't understand it → (auditory agnosia) may be due to lesion in (22) area.

the most common example of sensory aphasia is (**Wernicke's aphasia**);

People with Wernicke's aphasia may speak in long complete sentences that have no meaning, adding unnecessary words and even creating made-up words. For example; you know that smoodle pinkered and that I want to get him round and take care of him like you went before → This is called; word salad.

Wernicke's aphasia may be due to lesion in Wernicke's area.

Motor Aphasia (non-fluent);

- The most common example pf motor aphasia is (**Broca's aphasia**).
- People with Broca's aphasia have a damage that primarily affects the frontal lobe.
- They understand the speech and know what they want to say, but they frequently speak in short broken phrases that are produced with a great effort. They often emit small words like; is, and, the.

Agraphia;

- The patient can't express what he wants to say by writing but may can do this by speaking.
- This is due to a lesion in Exner's (hand skills) area (located just above the Broca's area).

Dysarthria;

- Inability to articulate speech properly. Occurs in;

UMNL→ stiff slurred speech,

- Ex; **Hemiplegia**→ the most common site is the internal capsule.
- Symptoms; deviation of mouth towards the healthy side (facial nerve paralysis).

LMNL→ nasal quality of speech.

Cerebellar disorders→ scanning or staccato speech.

Parkinsonism→ slow monotonies speech with masked face (no facial expressions).

Dysphonia;

- May be due to problems in vocal cords→ (بحة الصوت)

Cranial nerves examination

I. Olfactory → sense of smell.

II. Optic → vision.

III. Oculomotor → pupillary constriction / opening the eye (lid elevation) / most extra ocular movement

IV. Trochlear → downward, internal rotation of the eye.

V. Trigeminal

- Motor;
  - Temporalis and masseter muscles (jaw clenching).
  - pterygoid muscle (lateral jaw movement).
- Sensory;
  - To the face by its divisions (ophthalmic-maxillary-mandibular).

VI. Abducent → lat. deviation of the eye.

VII. Facial

- Motor;
  - Facial movements, including these of the facial expressions.
  - Closing the eyes and mouth.
- Sensory;
  - Taste on the anterior 2/3 of the tongue.

VIII. Acoustic → hearing; cochlear division- balance vestibular division.

IX. Glossopharyngeal

- Motor;
  - Pharynx.
- Sensory;
  - Post. portion of ear drum and ear canal.
  - Pharynx & post. 1/3 of the tongue.

X. Vagus

- Motor;
  - Palato-pharynx, larynx.
- Sensory;
  - Pharynx, larynx.

XI. Spinal accessory → motor to sternocleidomastoid + upper part of trapezius.

XII. Hypoglossal → motor to tongue.

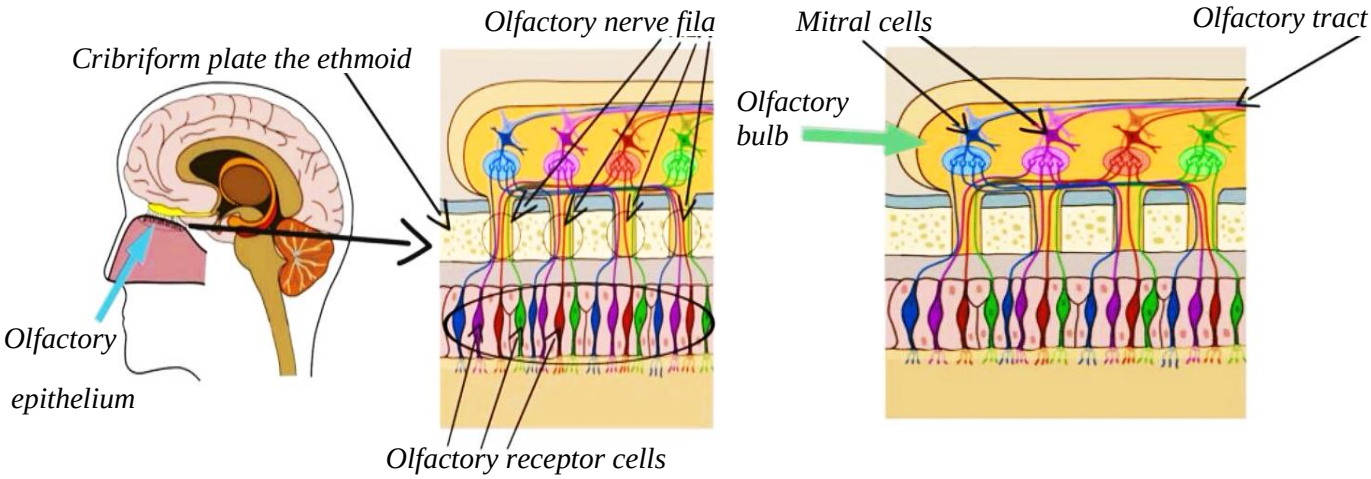
I. Olfactory;

Type & function;

Sensory nerve responsible for olfaction or smell to the brain.

Pathway;

- Begins in the olfactory epithelium in the nasal cavity which contains millions of olfactory receptor cells.
- The axons areas of which form bundles called (**Fila**). They travel through holes in cribriform plate of ethmoid bone that separate the nasal cavity from the brain. The fila make up the olfactory nerve. Which travel to an adjacent structure called the **olfactory bulb**. Where it forms synaptic connections with the olfactory neurons called the **Mitral cells**.
- The Mitral cells carry information about smell to the olfactory cortex as a part of olfactory tract.



☒ Damage to olfactory nerve can happen in number of ways such as→Trauma or tumors.

- When the olfactory nerve is damaged, the sense of smell is affected.
- The defect can include;

☒ **Anosmia**→ complete loss of smell.

- Varying levels of impaired or disturbed olfaction.
- The defect is also linked to abnormalities in flavor perception.

Examination of the olfactory function;

✓ Crude test; Start with simply asking the patient if he smells or not. Then if he notes some changes to sense the smell or the taste. If he said 'yes' ask him for any disease of the nose, sinusitis or nasal congestion.

✓ Specific test; To test each nostril, ask the patient to close his eyes and one nostril. Bring any common and safe smelling objects like; (lemon, vinegar, coffee or chocolate) near

his open nostril and ask him to identify the smell of the object. **Don't use any irritant or noxious substance like ammonia.** You can use alcohol.

- ✓ The patient should identify all the smelling objects in the test to be considered normal- therefore, you have to use ***well-known*** substances.

- How to differentiate between severe anosmia and simple anosmia caused by cold?
- Cold usually causes bilateral anosmia temporarily, which is usually associated with common cold symptoms. However, severe anosmia is usually unilateral and it may indicate nasopharyngeal cancer, foreign body or atrophy.

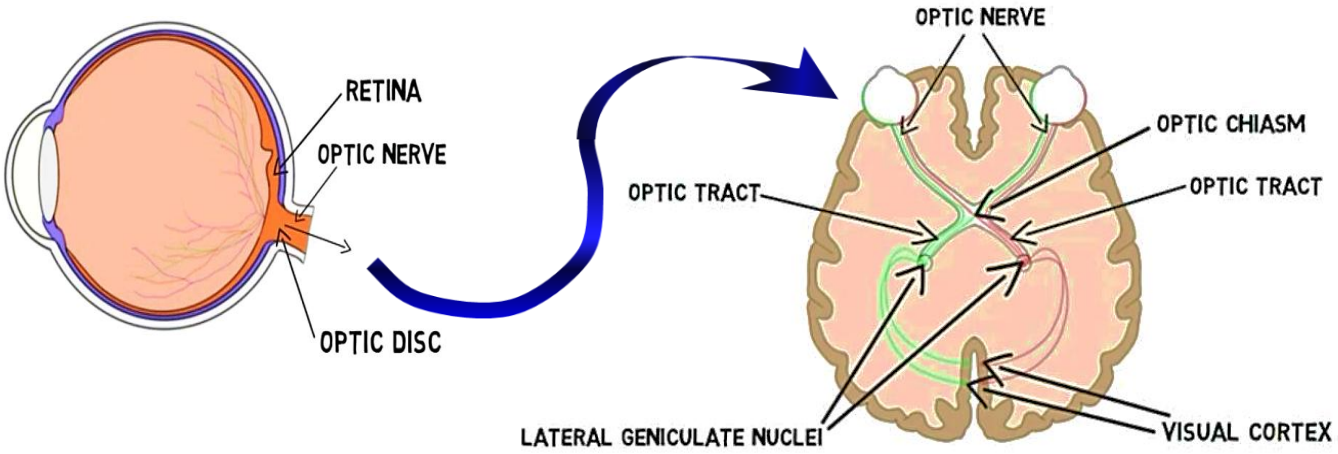
II. Optic nerve[1];

Type and function;

It is a sensory nerve responsible for transmitting information about the vision to the brain.

Pathway;

- It begins at the retina as the axons of the cells called (**retinal ganglion cells**) come together to leave the eye at a region called the (**optic disk**) and from the optic nerve.
- The optic nerve leaves the eye and extend to a structure called the **optic chiasm** where it meets the optic nerve of the other eye.
- At the optic chiasm, the optic nerve fibers carry the information from the sides of retina closest to the nose. And cross over the other side of the brain. While those carrying the information from the sides of the retina closest to the temples remain in the sides of the brain where they are.
- After leaving the optic chiasm, the nerve fibers are referred to as the **optic tract**. Most of the nerve fibers at the optic tract end at the **lat. geniculate nucleus** at the **thalamus** and from there the information will be passed in to the visual center of the occipital lobe.



[1] *Frequently asked about in exams.*

☒ Damage of the optic nerve can occur due to; trauma, tumors, glaucoma…etc.

Examination of the optic nerve;

Testing the optic can be remembered by the word AFRCO;

- **A**→ stands for **a**cuity.
- **F**→ stands for **f**ield.
- **R**→ stands for **r**eflexes.
- **C**→ stands for **c**olor.
- **O**→ stands for **o**phthalmoscopy.

Visual acuity;

Refers to the clarity of vision.

Assessing the visual acuity;

✓ Crude test;

- Use a torch light, stand one meter away from the patient and ask him is the torch on or off. If he answers correctly, increase the distance between you gradually repeating the test till reaching 6 meters.
- Wave your hands, ask him if he sees them, stand one meter away from him and ask him to count your fingers, increase the distance gradually repeating the test till reaching 6 meters.
- Ask him to count your fingers while being one meter away. If he counts them correctly, continue the procedure increasing the distance gradually till reaching 6 meters.

✓ Specific test;

- Use Snellen chart;

1. Ask the patient if he wears glasses or contact lenses to remove them. and stands or sits 6 meters (20 feet) away from the chart.
2. Ask him to close one eye and read the lowest line he can.
3. Then ask him to do the same by the other eye.
4. Finally, ask him to read by both eyes.

- You can use a hand-held chart.

What does 6/6 or 20/20 mean?

- 6/6 meters or 20/20 feet means that a person can see from 6 m (20 F) what a normal person can see from 6 meters. to be more clear, if a patient got (20/200 F= 6/60 m) - for example- in visual acuity test, this means he can see from 20 feet what a normal person can see from 200 feet and this is so bad.

- It is always preferred to begin with the crude then the specific test to detect the clarity of vision in general.

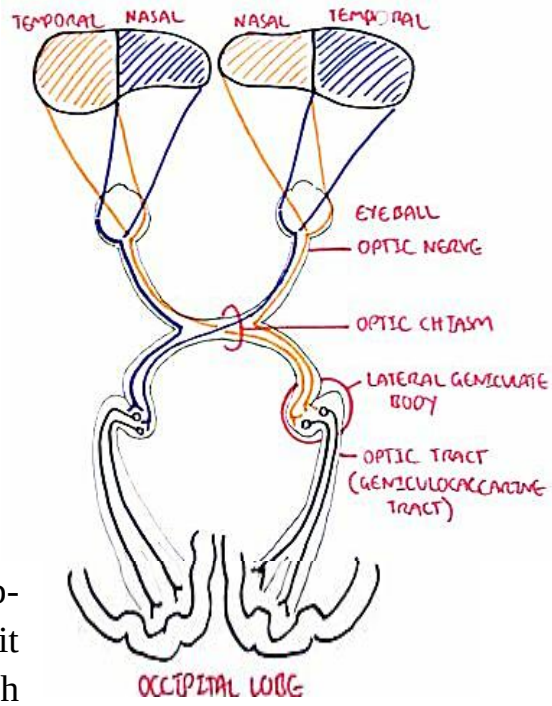
- If you start with the specific test and the patient can't read the largest letters of the chart, you should apply the crude test. Ask him to count the fingers and if he cannot see the fingers, then the hand is moved infront of his face, if he can't see the hand movement then a light is shown into his eyes.

Visual field;

Assessing the visual field;

✓ Crude test (***Confrontation test***);

- Sit approximately 1 meter (to 60 cm) from the patient facing him.
- Look at the patient's nose and get him to look at yours.
- Test each eye separately.
- Ask the patient to cover one eye and you should cover your eye which is opposite to his.
- Start at the top outer quadrant, move the target object (usually your finger) in from the side and ask the patient to tell you when he first sees the object and as you move towards the center whether it disappears (Blind spot). Repeat the process for each quadrant of the eye then for the other eye separately.

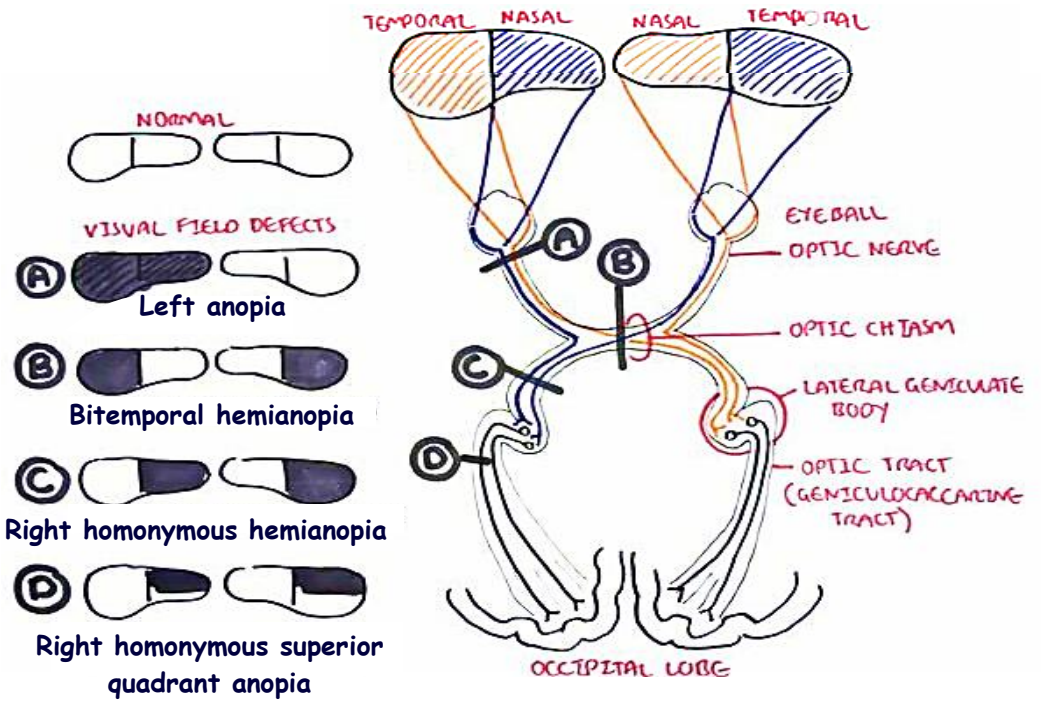


- This taste is based on comparing the visual field of the patient to that of the examiner- which is supposed to be normal.
- Normally, each person has a blind spot which is too small be detected.

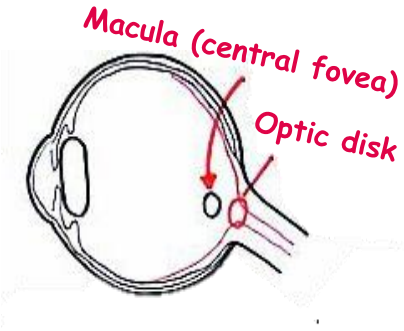
✓ Specific test (***Perimetry***);

- This procedure is conducted by an instrument called ***perimeter***.
- Each eye is tested separately, the other should be covered.
- The head of the patient is positioned on the perimeter by the chin supporter with the tested eye fixed on the center of the perimeter.
- A target -ex; a picture- is shown and the patient is asked to tell when it is first seen.
- The procedure is repeated in different meridians, the blind spots are recorded on a special visual field chart and the line joining them indicates the visual field boundary.
- The test is repeated for the other eye.

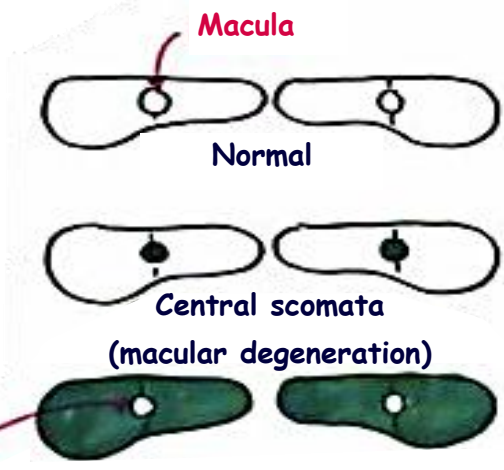
Lesion of the optic pathway;



- Macula (Central Fovea) contains the cones. Allows for high resolution.
- Damage of it→ loss of central vision.



Damage of macula → loss of central vision



Macula sparing (tunnel vision)

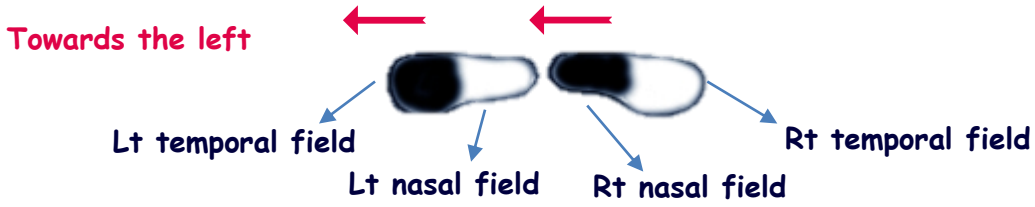
Constricted visual field (glaucoma, retinitis pigmentose)

A) Lesion of the left optic nerve causes→ **Left anopia**; blindness of the left eye. It's the same if the lesion was in the Rt. optic nerve→ Rt. eye blindness.

B) Lesion in the optic chiasm causes blindness of the nasal sides of both eyes. So there is inability to see the temporal field, condition is called **bitemporal hemianopia**.

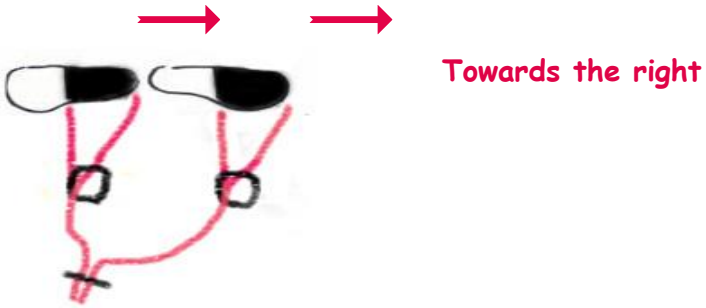
C) Lesion of the optic tract before the lat. geniculate nucleus causes contralateral homonymous hemianopia.

- If it is at the right tract, then there is blindness in the temporal side at the Rt. eye and of the nasal side of the Lt. eye. So the patient can't see the left temporal field and the right nasal field.



- The condition is called **left homonymous hemianopia**.

- If the lesion is at the left tract → blindness of the nasal side of the right eye and the temporal side of the left eye, then the patient can't see the right temporal field and the left nasal field. (a condition called; **right homonymous hemianopia**).



D) Partial lesion at the optic radiation can cause blindness (partial) at certain quadrants of the eyes. For instance, partial lesion of the left optic radiation; patients with that lesion can't see the upper quadrant of the right temporal field and that of the left nasal field.

Examination of the blind spot;

- Everyone has a blind spot in his vision of each eye called physiological blind spot or point or black spot (punctum caecum), (central scotoma; not normal).
- To test it;

1. Sit approximately 60 cm to 1 meter from the patient facing him.
2. Look at the patient's nose and get him to look at yours.
3. Ask him to cover his left eye, and you cover your right one.
4. Use a small colored tip (usually red) to test the blind spot; because the central field of vision is deficient in cones which detect the color.
5. You must make sure that you are holding the colored tip half way between you and the patient, because you are comparing your blind spot with his, to see if they are the same;

a. Move the tip from the lateral side of the opened eye inward and ask the patient to tell you when the tip disappears and when it backs. Then move it from above downward in front of the open eye and ask him to tell you the same thing.

6. Do the same way with his other (left) eye.

Ophthalmoscopy or Fundoscopy;

- ✓ The retina is the only portion of the central nervous system visible from the exterior, and this is done by the ophthalmoscope. It allows a better view of the fundus of the eye even if the lens is clouded by cataracts.
- ✓ The fundus consists of; Retina - optic disk - blood vessels.
- ✓ Visualization of the fundus by the funduscope is better in the dark, thus, it is preferred to turn lights off during the procedure.

- This test is often included in routine eye exam to screen the eye disease.
- The doctor may also order it if you have a condition that affects your blood vessels, such as high blood pressure or diabetes. Other conditions like;

- Optic nerve damage.
- Retinal tear or detachment.
- Glaucoma (excessive pressure on eye).
- Macular degeneration → loss of central visual field.
- Hypertension – diabetes.
- Cytomegalovirus retinitis (CMV).

Reflexes;

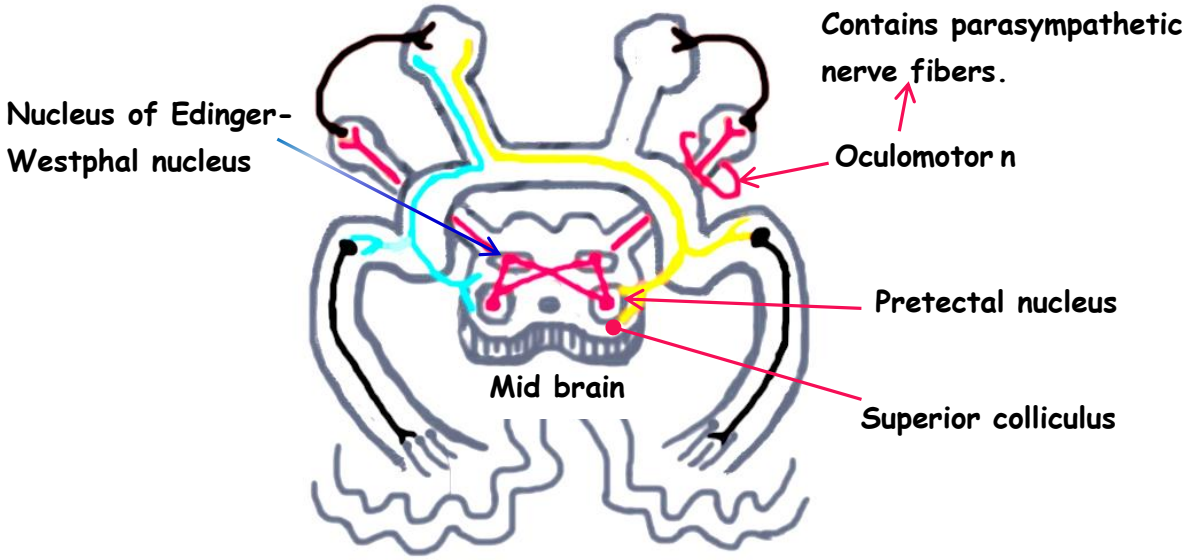
- ✓ Light reflexes;

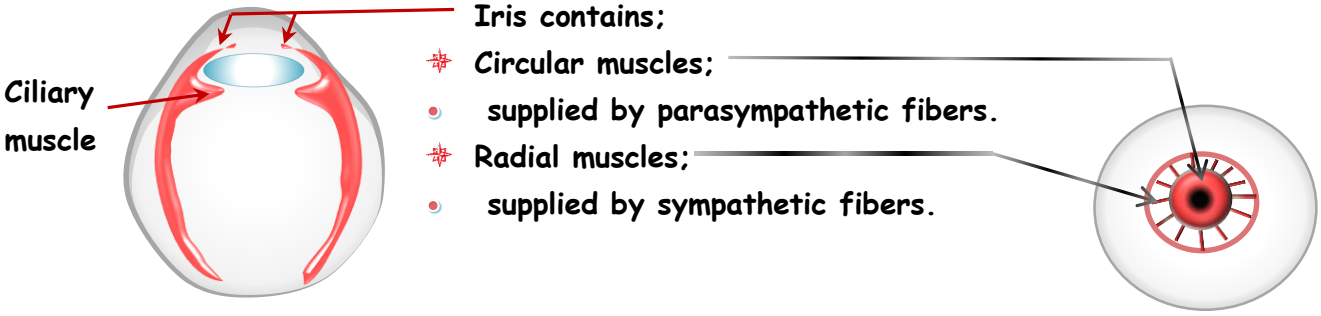
Direct ***Indirect*** ***Swinging***

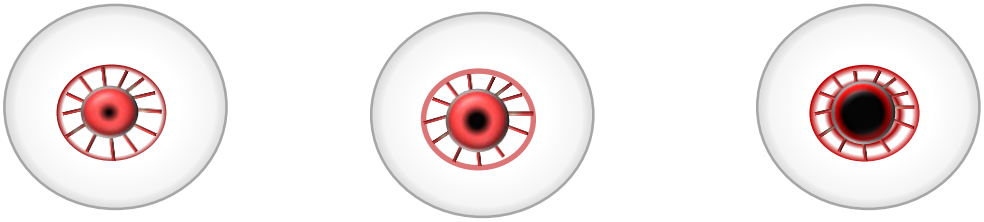
- First; if the patient wears glasses ask him to take them off, then;

1. You need a "pen-light" or torch.
2. Ask the patient to focus on something at least 15 feet away.

- The idea of the test; detecting how the pupil constricts when you shine a light on the eyeball. To understand let's see the visual pathway;







Constricted (***Miosis***)

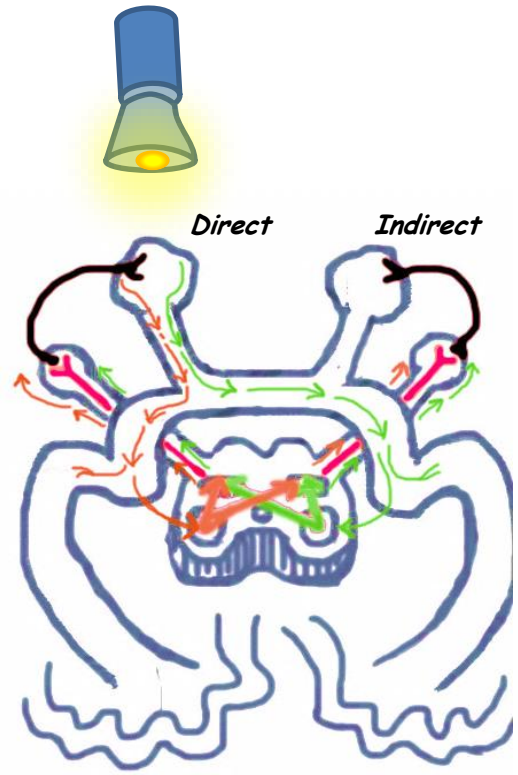
Normal

Dilated (***Mydriasis***)

- Para sympathetic via 3rd cranial nerve.

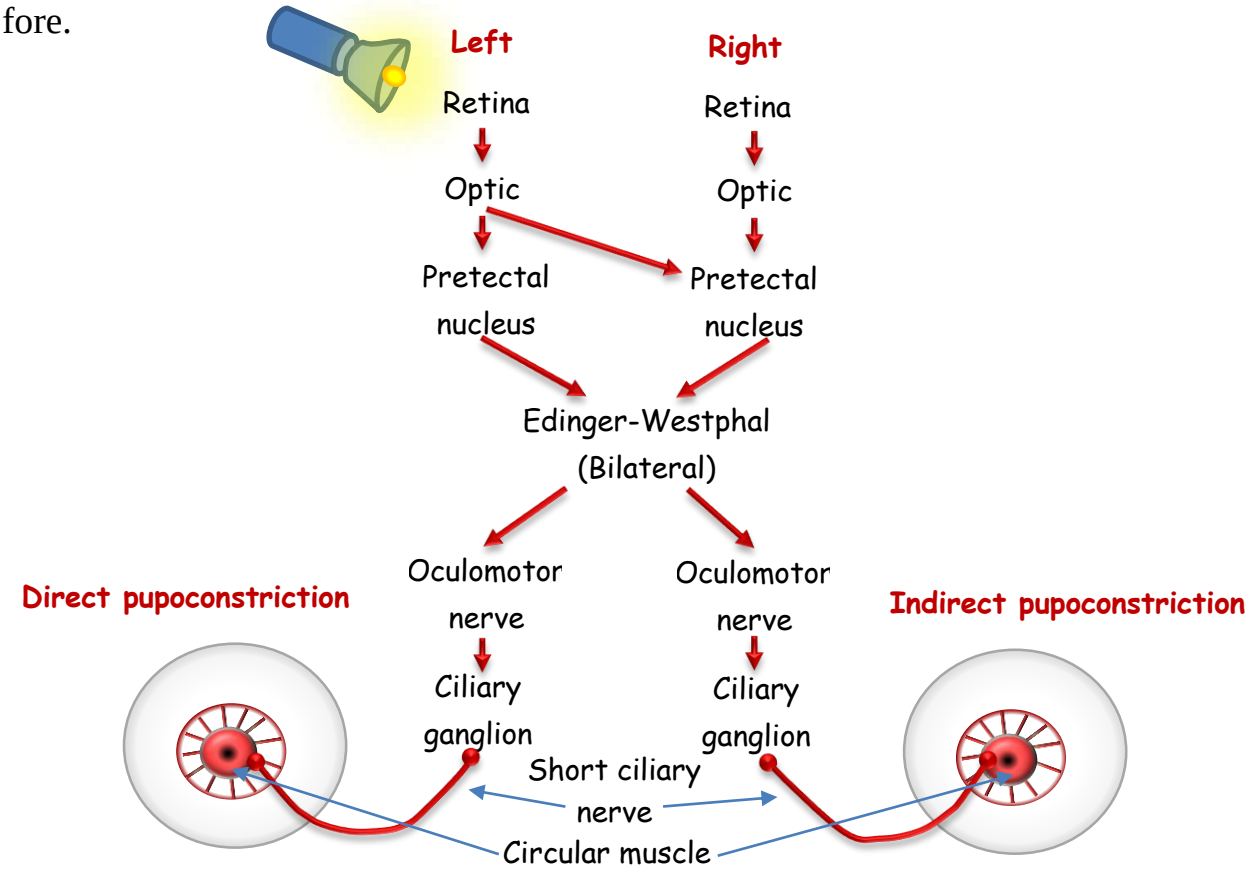
- Sympathetic nerve fibers.

- When you shine the light on one eye and the pupil is constricted, this is called; ***Direct light reflex.***
- The other eye also constricts although the light is not shined on it and this is called; ***indirect (consensual) light reflex.***



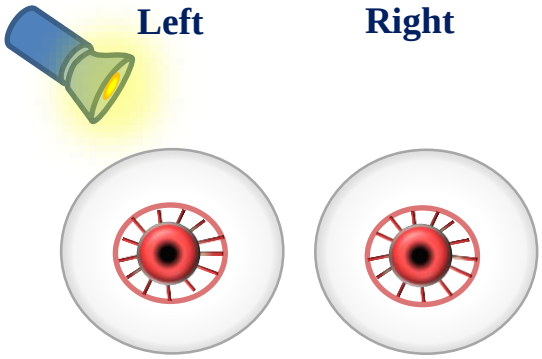
Mechanism of direct and indirect response;

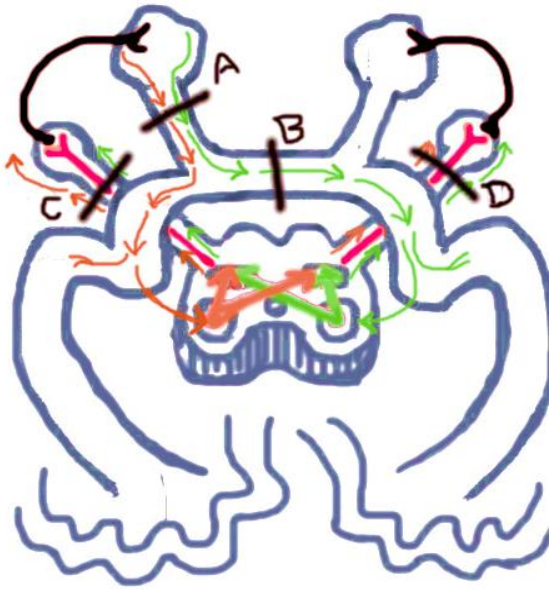
1. The nerve fiber of the optic nerve laying in the temporal side will pass toward the lateral geniculate nucleus where it sends synaptic fibers to the nearest pretectal nucleus in the midbrain.
2. The later nucleus also sends synaptic fibers to both Edinger-Westphal nuclei (right & left) which in turn transmit the impulse to the parasympathetic fibers in the oculomotor nerve to the iris to stimulate the circular muscle and cause miosis in both eyes.
3. Also the nerve fiber of the optic nerve laying in the nasal side crosses over in the optic chiasm to reach the lateral geniculate nucleus of the opposite side where it sends synaptic fibers to the pretectal nucleus of that side which work by the same mechanism of the other pretectal nucleus mentioned before.



Abnormalities;

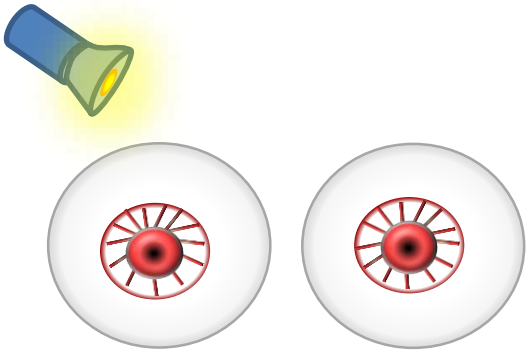
A)





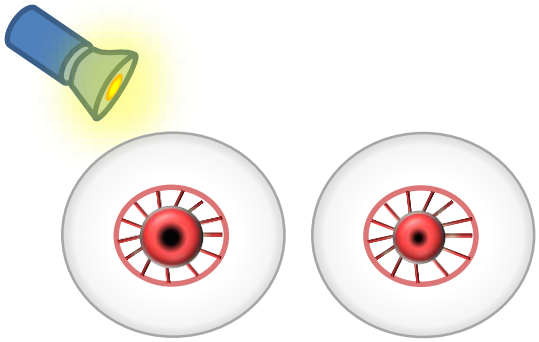
- **No response.**
- Damage to the **left** optic nerve.
- Reflex → **absent.**

B)



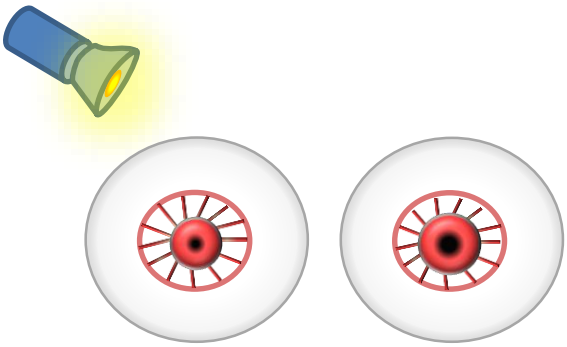
- Damage to the optic chiasm.
- **Light** reflex is **present**.

C)



- Damage to the **left** oculomotor nerve.
- **Direct → absent.**
- **Indirect → present.**

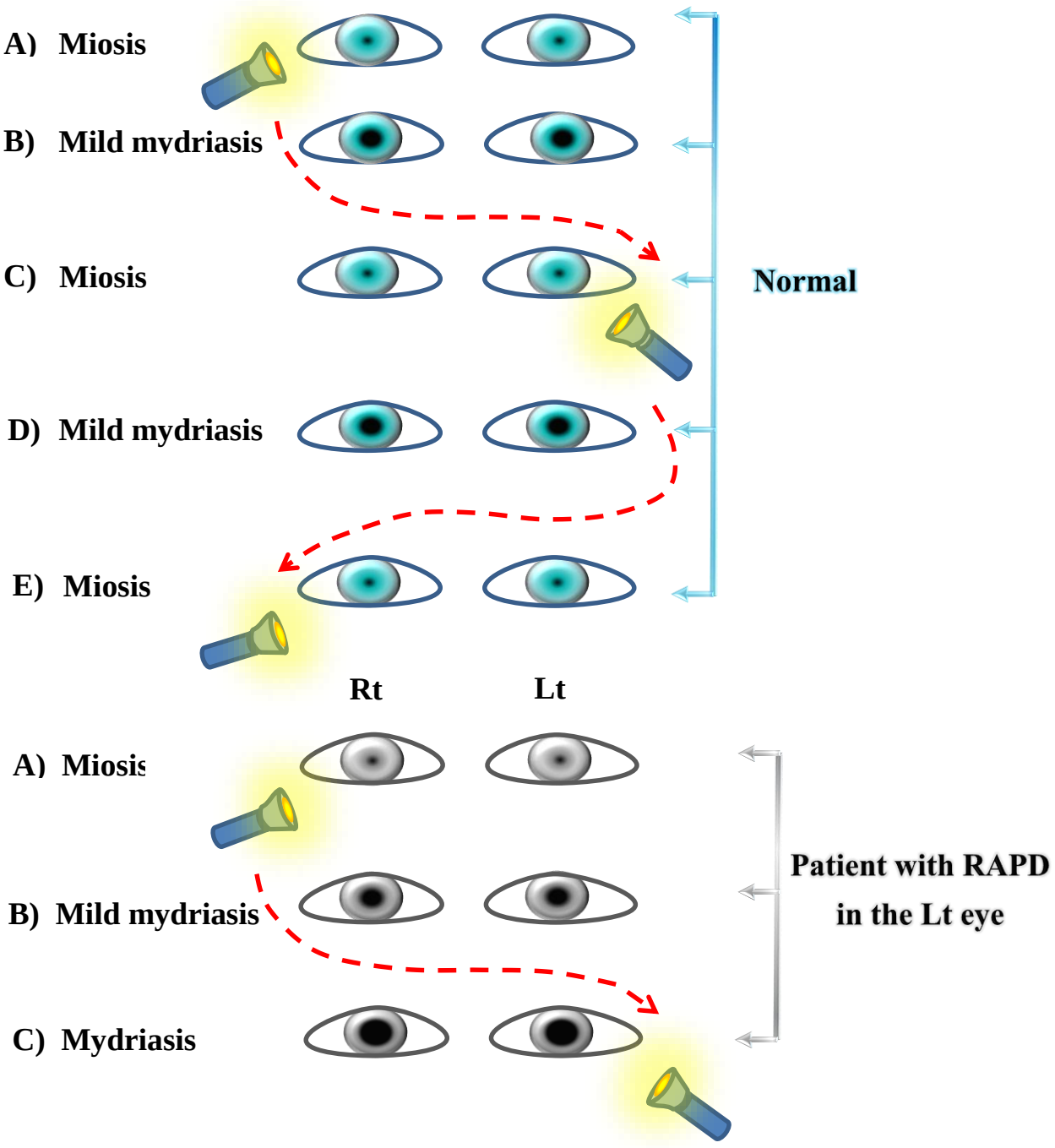
D)



- Damage to the **right** oculomotor nerve.
- **Direct → present.**
- **Indirect → absent.**

Swinging tight reflex;

- Used to check if there is an RAPD (relative afferent pupil defect).
- It is done by shining one eye for 2 seconds then shining the other eye immediately after the former eye for 2 seconds then back to the other eye and note the pupil size.



What is RAPD?

- RAPD - also called (Marcus Gunn pupil); Means having a defect in the pupil pathway in the afferent side not the efferent side. It is detected as a relative because its relativity to the follow eye, that defines the RAPD so we can detect the RAPD by comparing the responsivity to the light in both eyes i.e; defect in the retina, optic nerve, pretectal nucleus (tectal RAPD).

Colors of the vision;

Assessed by;

- Crude test; conducted by using colored objects – pins for example – and asking the patient to tell the color of each.
- Specific test (***Ishihara's test***);
  - It uses pales (cards) made up of multicolored dots, some of the dots will be of a different color and depict a number.
  - The patient will be asked to look at the plate and say if he sees a number.
  - A note will be taken of numbers that he has difficulty to identify or identified incorrectly.
- Different Ishihara's plate tests can be used to detect different types of color vision deficiency.
- The most common test is used to detect a red color deficiency.

Examples for disorders;

- Protanopia; condition of inability to see red.
- Deuteranopia; condition of inability to see green.
- Tritanopia; condition of inability to see either blue or yellow.

- There are 2 main types of colors vision deficiency;
- Red-green deficiency; people are unable to distinguish certain shades of red and green (most common).
- Blue-yellow deficiency (rare); it is difficult to distinguish between the blue, green and yellow, may appear as a pale grey or purple.

Summary of 1st and 2nd cranial nerves examination and problems

Olfactory nerve

Tested by;

Crude test ***Specific test***

- Use safe not irritate or noxious smelling objects
- The eyes of the patient should be closed.

Abnormalities

Anosmia

Bilateral
Due to;
- Common cold
- Hysteria

Unilateral
Fraction in cribriform plate
- Meningitis
- Tumor in the uncus of the temporal lobe which compresses the olfactory nerve.

Optic nerve

Tested by examination of the following

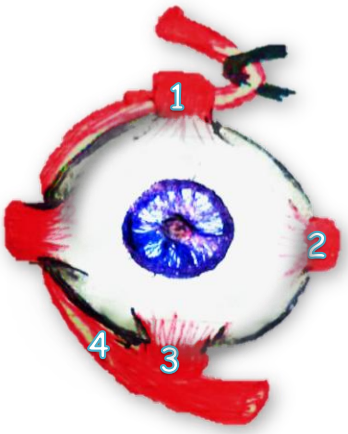
- Visual acuity
- Visual field
- Reflexes
  - By a pen light or torch
    - Direct
    - Indirect
    - Swinging
- Colors
- Ophthalmoscopy

Test	Crude	Specific
Visual acuity	1) Light perception. 2) Hand movement. 3) Finger counting. • Begin with 1 meter far then increase till 6 meters.	Snellen chart.
Visual field	Confrontation test	Perimetry.
Color	Using colored pins.	Ishihara's test.

III. Oculomotor nerve;

Type and function;

Motor nerve that supply 5 of 7 extraocular muscles[2], which are;



1. Superior rectus.
2. Medial rectus.
3. Inferior rectus.
4. Inferior oblique.
5. Levator palpebrae superior muscle (inserted to the upper eyelid).

- In addition, it supplies the circular muscle of the iris (pupillary constrictor muscle).

Pathway;

- Oculomotor nerve originates from the oculomotor nucleus in the midbrain. From here, it travels to the orbit of the eye along the way separating into branches that control the different extraocular muscles.
- The fibers controlling pupillary constrictor and the ciliary muscles originate in the Edinger-Westphal nucleus, and travel with the oculomotor nerve.

Action of muscles supplied by (III) nerve;

1. Superior rectus; looking up.
2. Inferior rectus; looking down.
3. Medial rectus; looking medially.
4. Inferior oblique; looking upward & laterally.
5. Circular muscle; pupil constriction (miosis).
6. Ciliary muscle; accommodation of the power of lens.

Oculomotor nerve examination;

To examine the oculomotor nerve, you have to test the eye movement and the pupil related reflexes noting the initial size of the pupil and others;

Eye movement;

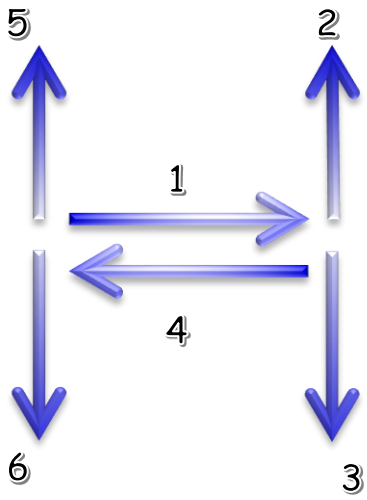
✓ Crude test;

- Ask the patient to follow your finger while moving from right to left.
- The other eye should be closed then tested separately.

[2] *Frequently asked about in exams.*

✓ Specific test;

- Ask the patient to look up, down, left then right; this is applied by asking the patient to look at your finger while moving in an (H) shaped manner.
- The patient should not move his neck.
- This procedure can be applied on both eyes at once.

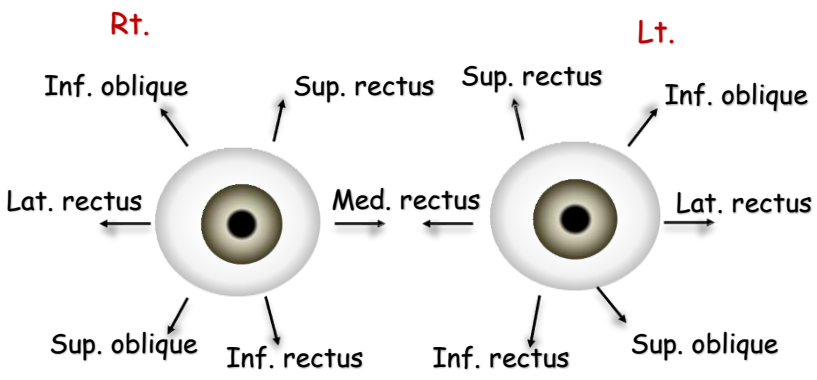


According to the side of the defected movement, the affected muscle is detected;

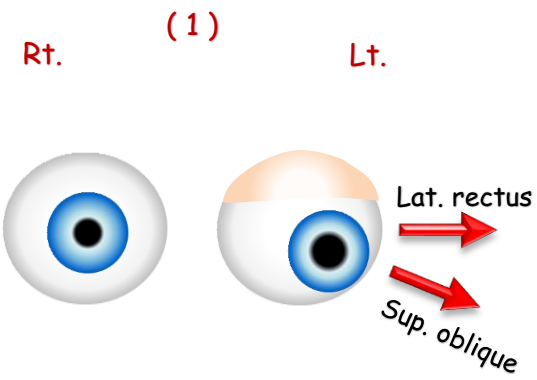
1) Medial rectus.
2) Superior rectus with inferior oblique.
3) Inferior rectus with superior oblique.
4) Lateral rectus.
5) Superior rectus with inferior oblique.
6) Inferior rectus with superior oblique.

Abnormalities include;

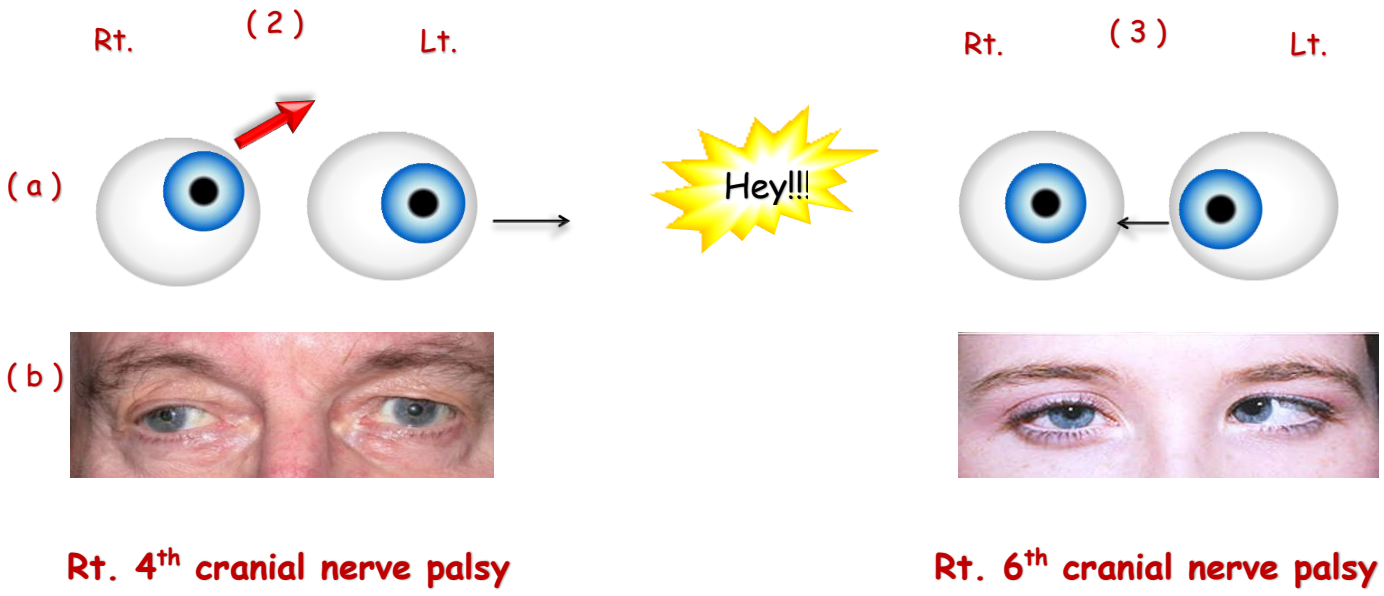
1) Downward and lateral deviation of the eye with difficulty moving the affected eye medially. This is due damage of the ipsilateral **3rd** cranial nerve.
2) Upward drift of the eye when the patient looks to the opposite side (healthy side). This is due **4th** cranial nerve palsy causing paralysis of the superior oblique muscle (responsible for downward and lateral movement of the eye), thus, over acting of the inferior oblique muscle (with the superior rectus maybe) when the patient looks medially (a). In addition, paralysis of sup. oblique muscle results in weakness in lateral and downward movement of the eye (b).
3) Inability of the affected eye to move out (laterally) due to **6th** cranial nerve palsy resulting in paralysis of lateral rectus muscle. (better taken to 6th nerve examination, or left in case of generalized examination)



Normal



Lt. 3rd cranial nerve



Rt. 4th cranial nerve palsy **Rt. 6th cranial nerve palsy**

Pupil;

1. Inspect generally for squint and palsies.
2. Examine pupil shape and symmetry;

Normally, it is RRR; Round, Regular, Reactive (responds to light → see light reflexes).

Abnormalities;

Anisocoria;

- Unequal pupil sizes.
- The eyes should by assessed to determine whether it is abnormal (for many causes) or normal (physiological anisocoria in 20% of population).

Reflexes;

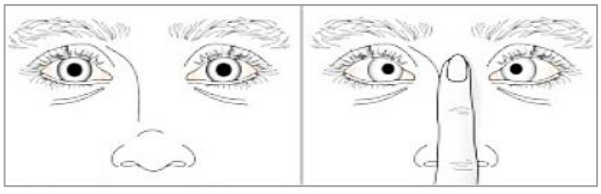
Light reflexes (see page 14).

- ✓ Afferent ⟹ optic nerve.
- ✓
- ✓ Efferent ⟹ oculomotor.

Accommodation reflexes;

- It is tested in routine neurological examination by asking the patient to look at a close (1 foot away) target after fixation (focusing) on a distant target (don't use a light source), the following should be noted;

1. There should by constriction of the pupil on near gaze.
2. A squint occurs temporarily.



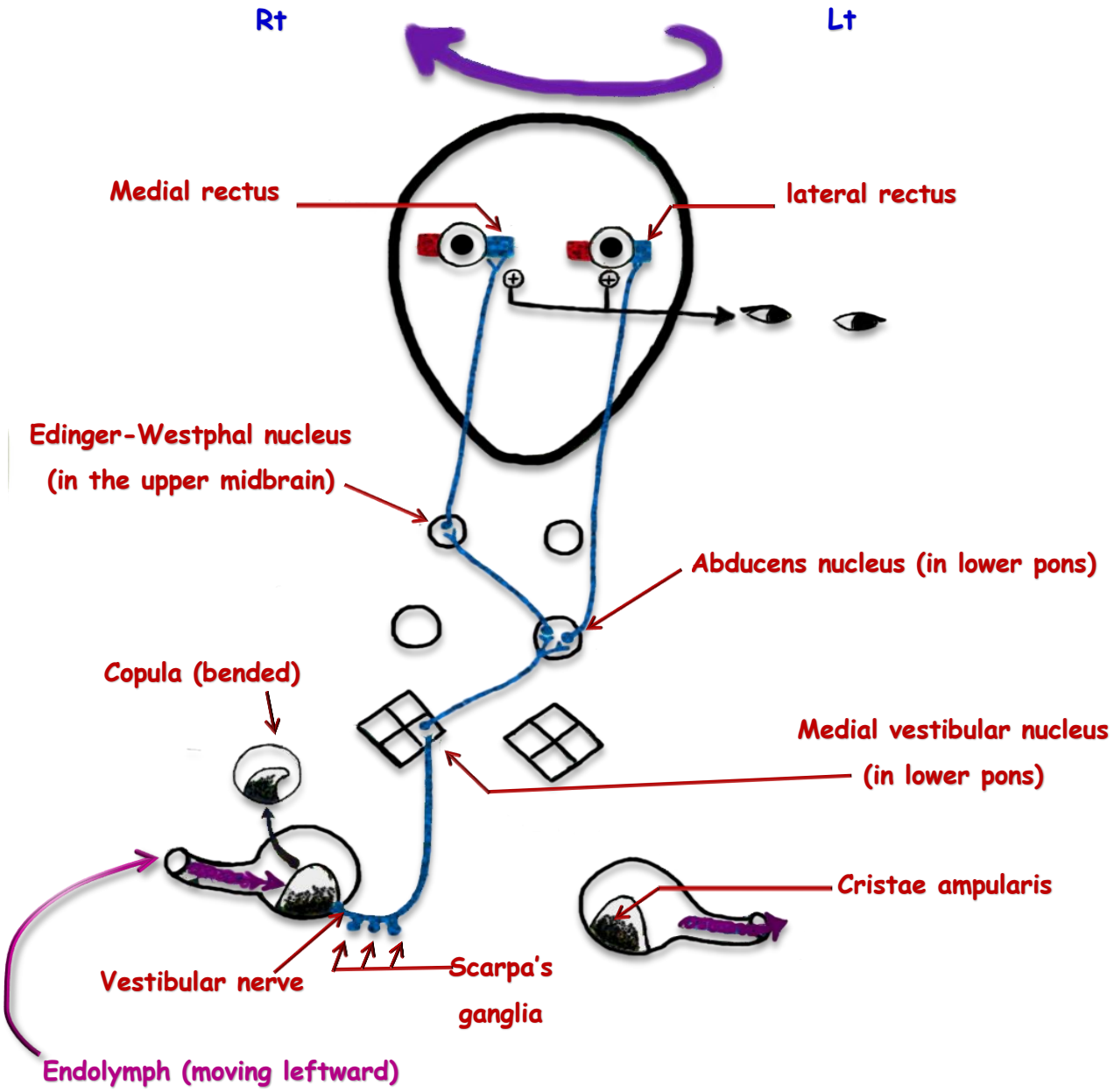
- Failure to constrict to light -see light reflex- but constriction on near gaze is referred to as light–near dissociation. It can be caused by a midbrain lesion as seen in the (Argyll Roberson pupil of syphilis) and a ciliary ganglion lesion (Adie's pupil).

- Initiation of reflex;
- The afferent → Optic nerve.
- The center → Occipital lope.
- The efferent → Oculomotor nerve.
- The response;
- Conversion (temporal squint).
- Miosis.
- Ciliary muscle contraction.

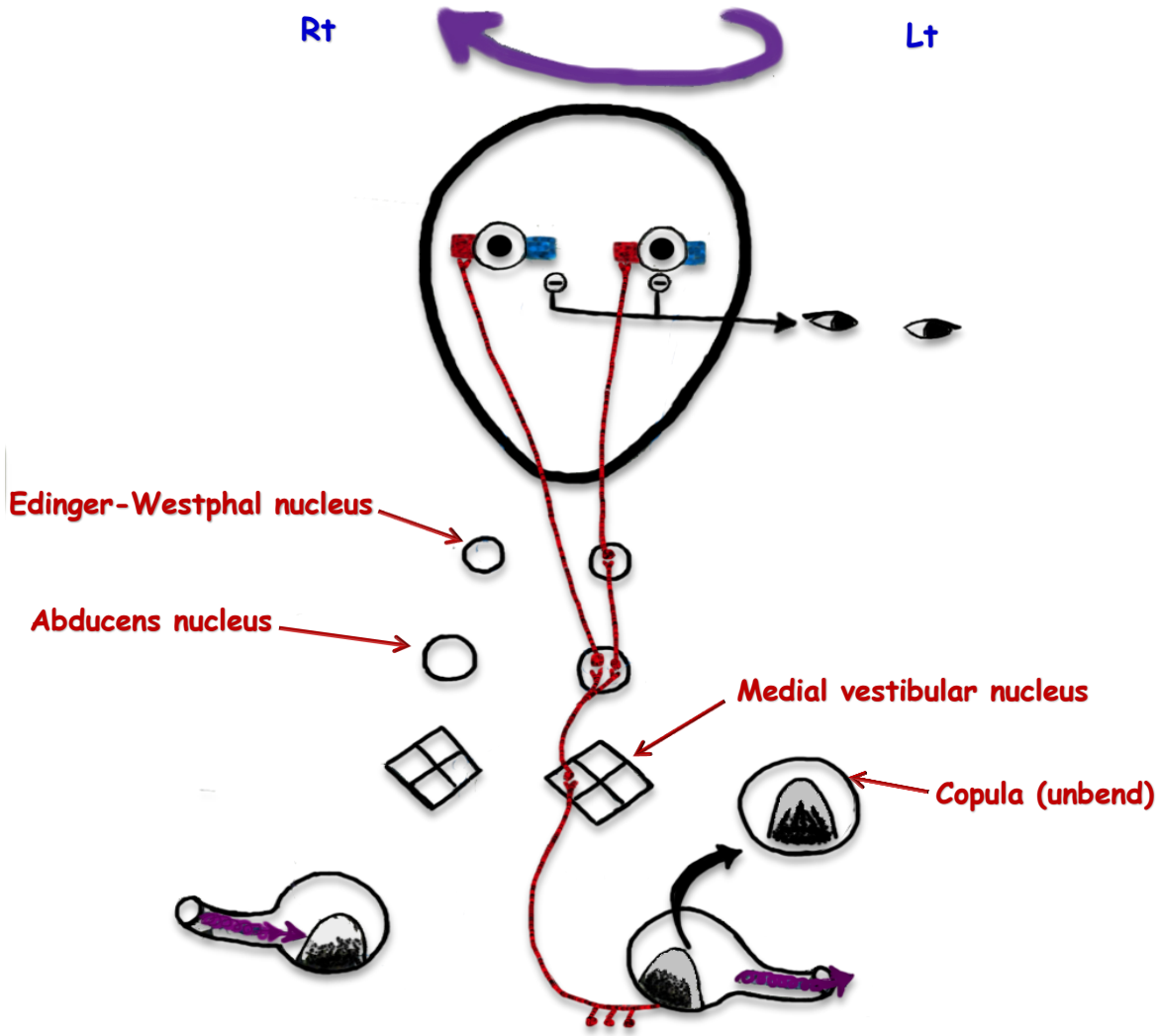
- The eye movement;
- Oculo-encephalic reflex (V.O.R; vestibule-ocular reflex or Doll's reflex);

- What's the V.O.R and why do we need it?
- The V.O.R reflex explains the relation between the head movement and the relative eye movement as follows;
- Motion sensors (receptors) of the vestibular system stimulate the nerves controlling the extraocular muscles so if the head is rotated to the **right**, eyes should rotate to the **left** to keep the image of the object on which the person's focus is, on his fovea. And if the head is rotated to the left eyes will rotate to the right and so on. So, the movement of the head leads to opposite movement of the eyes and in the same degree which is a compensatory movement. Thus, the image remains clear and doesn't get blurred.

- Pathway;
- ✓ This reflex is excitatory and inhibitory at the same time, as follows;
- When the head is moving to right the endolymph in the semicircular canal of the right ear moves leftward by its inertia towards the cupula stimulating the cristae ampularis (by binding to the cupula on the left).
- Then the vestibular nerve is stimulated sending impulses through nerve fibers to the medial vestibular nucleus which in turn sends impulses to the contralateral abducens nucleus (on the left side).
- Abducens nucleus (on the left) sends fibers to the lateral rectus muscle (abducens nerve) and to the right Edinger-Westphal nucleus to excite the medial rectus muscle of the right eye, and these 2 muscles contract and pull the eyes to the left.



- At the same time, the endolymph of the left ear moves to the left opposite to the right-ward movement of the head by its inertia, so it doesn't bind the cupula (which is to the right) because it is moving away from it. On the other hand, the cupula will move laterally away from the kinocilium following the endolymph. This will cause inhibition to the left vestibular nerve (hyperpolarization) leading to inhibition of the muscles that moves the eyes rightward in a similar pathway to the former stimulatory pathway;



Testing the V.O.R;

- With the patient supine, ask him to look at your face.
- Gently, turn his head from side to side, noting the movement of the eyes.

This can be performed on a comatose patient.

Damage of the oculomotor nerve;

- Causes deficit in the ipsilateral eye (same side as the damage), characterized by the following;

1. ***Ptosis*** (can be complete or partial according to the lesion); due to paralysis of the levator palpebrae superior ⟹ responsible for voluntary elevation of the upper eyelid.
2. ***Mydriasis***; due to paralysis of the circular muscle of the retina.
3. ***Diminished accommodation reflex in the affected eye***; due to paralyzed ciliary muscle.
4. ***Divergent squint***; deviation of the affected eye laterally and downward by the action of the lateral rectus and the superior oblique which are not supplied by the 3rd cranial nerve.
5. ***Diplopia/Exotropia*** (double vision).

Nystagmus;

- It's continuous, uncontrolled movements of the eyes. Biphasic or jerk nystagmus is the most common type. It is characterized by slow drift in one direction, followed by fast correction/recovery in the opposite direction.
- The direction of the fast phase detects the direction of the nystagmus. If there are equal oscillations in both directions, it is called "**pendular nystagmus**".
- It is caused commonly by vestibular disease.

Horner's syndrome;

- **Cause;** dysfunction of the sympathetic nerve supply to the eye.

Role of sympathetic nerve supply to the eye and face;

a. Mydriasis.
b. Exophthalmus.
c. Elevation of the eyelid by Muller's muscle (involuntary).
d. V.C of facial blood vessels.
e. Sweat secretion.

- **Symptoms;** Loss of sympathetic function in the face leads to;

1. Miosis.
2. Enophthalmos.
3. Ptosis.
4. Anhydrases (absence of sweat secretion).
5. V.D → the affected side of the face become warmer and redder.

IV. Trochlear nerve;

Type and function;

It is a motor nerve responsible for supplying the superior oblique muscle.

Examination;

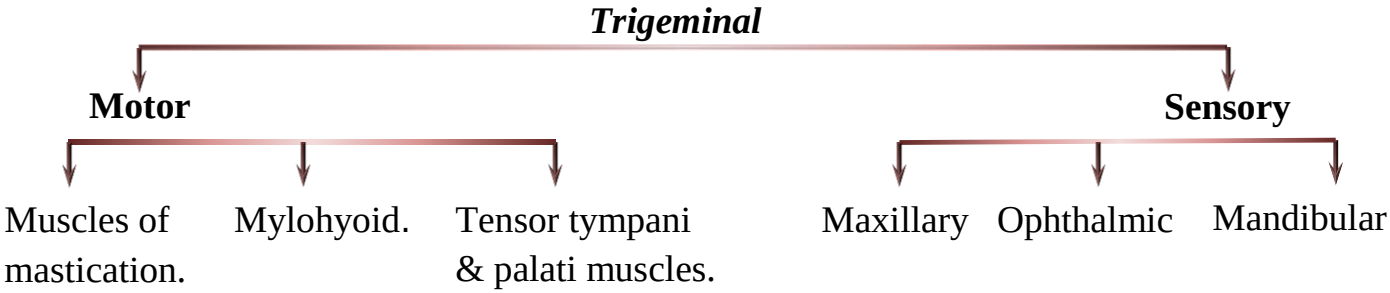
- By eye movement (downward and laterally) → see page 20.

Trochlear nerve palsy; see 20.

V. Trigeminal nerve;

Type and function;

Motor and sensory nerve supply to the face (the sensory nerve of the face except the angle of mandible ⟶ C2).



- The sensory portion of the trigeminal nerve supplies; touch-pain & temperature to the face. The innervation includes the cornea.
- Conjunctiva of the eye, mucosa of sinuses, nasal and oral cavities, and dura of middle, anterior and posterior parts of the posterior cranial fossae.
- The mandibular division carries the motor portion. The later conveys proprioceptive impulse from the temporomandibular joint.

A lesion of the sensory fibers leads to;

- Hypoesthesia (hypesthesia) or anesthesia of the supplied area.
- Corneal reflex is absent when the area of supply is the eye.
- Proprioception from the temporomandibular joint is absent when there is a lesion of the mandibular division.

Note;

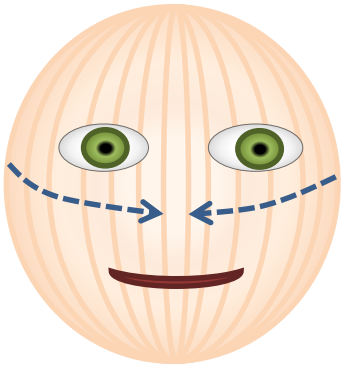
- Muscles of mastication produce elevation, depression, protraction, retraction and side to side movement of the mandible.

- The mandible upon opening deviates towards the **paralyzed** side when there is a unilateral paralysis of masticatory muscles – certainly, the pterygoid muscle – this direction is due to the action of the normal pterygoid muscle on the opposite side.
- The mandible drops, and no jaw movement is possible with bilateral paralysis.

Testing technique;

Sensory;

1. Tell the patient you are going to test the ability to feel touch or pain on the face.
2. His/her eyes should be closed.
3. Lightly touch (with a piece of cotton) either one or both sides of each of the three divisions of the trigeminal nerve;



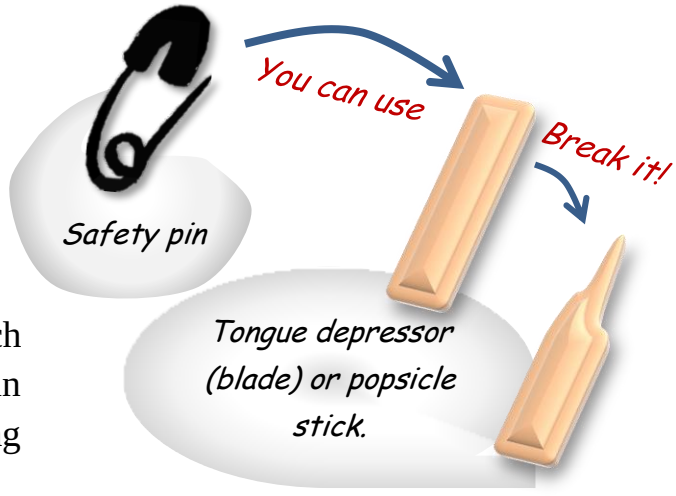
a. The face is divided onion like.
b. The test must be performed bilaterally; each point must be tested on both sides.
c. Test direction; from most lateral to most medial.

- Applying the test by this way is important to detect a disease called (**syringomyelia**) -causing cavitation around the central canal of the spinal cord extending up to the brain stem- before reaching the brain stem (**syringobulbia**) leading to bilateral loss of pain and temperature sensation and paralysis of some cranial nerves may appear.

4. Ask the patient to say whether you touched one or both sides of the face.
5. Ask the patient if he senses equal degree of touch at each division of both sides.
6. Don't touch the area upon the angle of the mandible when you are assessing the trigeminal nerve.

✓ **Next**;

1. Take a safety pin and gently prick first one side of each division then the other.
2. Ask the patient if there is any difference in the sensation on one side compared to the other.
3. With the patient eyes are closed, touch sometimes with the sharp point of the pin and other times with the dull part, asking the patient to describe the sensation.



✓ **Next**;

- Test the corneal reflex;

1. Begin by telling the patient you are going to touch the eye gently in order to check the reflex.
2. Take a wisp of cotton and twist it into a point.

3. Ask the patient to look in the other direction so you will not be testing the blink reflex.
4. Then gently but firmly touch the cornea at its junction with the sclera.

- Sensitivity to pain increases medially from this point and decreases laterally.
- The junction of the cornea and sclera is a good compromise between causing pain to the patient and obtaining the reflex.

5. There is a rapid blink of the eye being tested and a consensual blink of the other eye.

- If there is a 7th nerve weakness on the side being tested, then observe the consensual reflex (blinking of the eye of the other side).

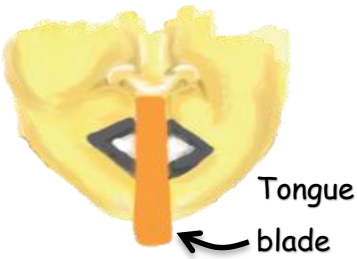
6. Test the glabellar reflex (see next).

- The corneal reflex;
- ✓ Afferent; trigeminal nerve.
- ✓ Efferent; facial nerve.
- ✓ Stimulus; touch of one eye.
- ✓ Response; blinking of both eyes.

Motor;

- Test for motor abnormalities as follows;

1. Observe the skin over the temporal and masseter muscles. Concavity or asymmetry suggests atrophy. The tip of mandible should be in the midline.
2. Ask the patient to clench his or her jaws. Palpate the masseter and temporal muscles for asymmetry of volume and for tone.
3. Observe for deviation of the tip of the mandible as the jaw is opened. Line up a (tongue blade) with the tip of the nose and the center of the mouth if there is 7th nerve weakness or problems with the nerve supplying the lat. Pterygoid. This maneuver makes it easier to perceive deviation (see the figure next), deviation is to the weak side. Ask the patient to move the jaw from side to side against the resistance of your palm.



4. Ask the patient to move the jaw from side to side against the resistance of your palm.
5. The paralyzed side will move laterally while the healthy side will not do, due to the opposite action of pterygoid muscles.

✓ **Next;**

- Test the jaw jerk reflex; it is a stretch reflex.

1. Demonstrate to the patient what you are going to do.
2. Have the jaws half open and relaxed.

3. Place your index finger on the tip of the mandible and tap your finger gently but briskly with a reflex hammer (tendon hammer).

- Normally; tapping the mandible produces no response or a brisk contraction.
- Abnormally; the reflex is hyperactive or repeating reflexes (clonus) with UMNL.
- With nuclear or infranucleur lesion–nucleus of 5th nerve–the reflex is absent.

- The jaw jerk reflex;
- ✓ Afferent; mandibular division of 5th nerve through its sensory fibers.
- ✓ Center; mesencephalic nucleus.
- ✓ Efferent; the 5th nerve through motor fibers running in the mandibular division (bilaterally).

VI. Abducent nerve;

Type and function;

Motor nerve supplies the lateral rectus muscles of the eye.

Examination; by eye movement (looking laterally) –see page 20.

6th nerve palsy;

- Causes inability to the affected eye to move laterally–see page 20.

VII. Facial nerve [3] ;

Type and function;

It is a sensory and motor (mainly) nerve.

Facial nerve

Sensory from;

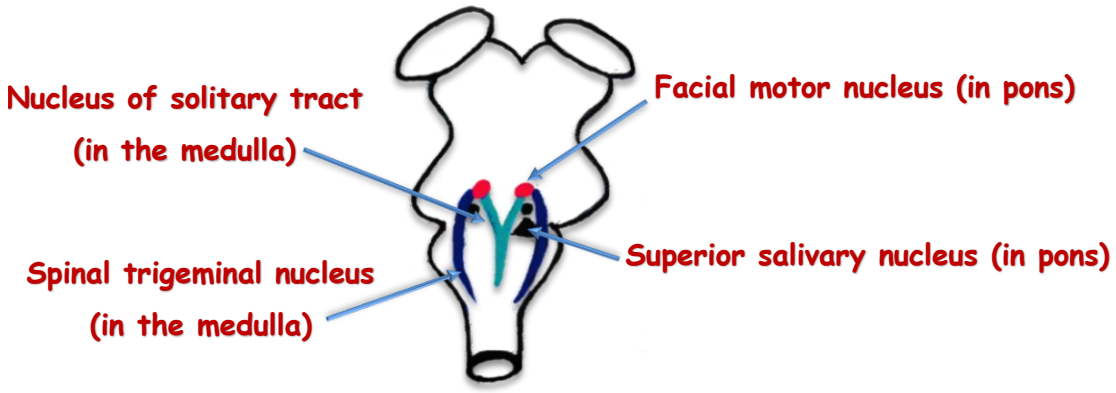
- Outer ear.
- Taste buds on the ant.2/3 of the tongue.

Supplies most major glands of the head.

Motor;

- Muscles of facial expressions.
- Certain muscles involved in swallowing and jaw movement.
- Muscles of external ear.
- Stapedius muscle (in the middle ear).

[3] *Frequently asked about in exams.*

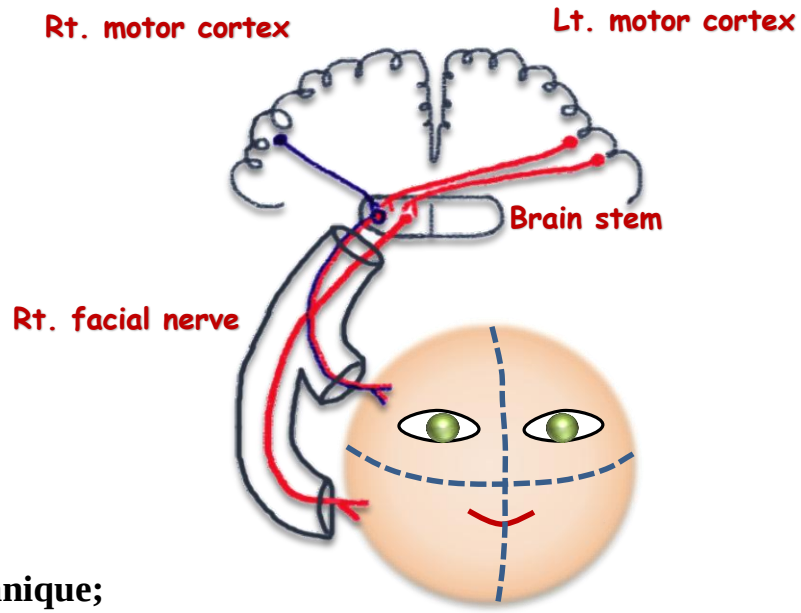


- The motor portion of the facial neve originates from the facial motor nucleus in the pons.
- The portion that supplies the glands originates from the superior salivary nucleus in the pons.
- Taste information travels to the nucleus of the salivary tract in the medulla.
- Sensory information from the outer ear travels to the spinal trigeminal nucleus in the medulla.

Upper motor neuron of the 7th nerve;

- The 7th cranial nerve emerges from the brainstem to supply the muscles of the face.
- Voluntary control of the facial nerve of each side of the face comes from a region in the brain called the motor cortex. For example;

- An upper motor neuron extends down from the left motor cortex, goes across the mid-line of the brainstem to the right side. From here, a lower motor neuron emerges to the face as a part of the right facial nerve which supply the lower part of the right side of the face.
- For the upper half of the right side of the face, things start similarly, there is another upper motor neuron that extends down from another region of the left motor cortex, also goes across the midline in the brainstem and synapse with another lower motor neuron, which also continue as a part of the Rt. facial nerve to supply the upper half of the face. One huge difference, that there is another upper motor neuron arises in the right motor cortex (other than the left) and descends downwards without crossing to the brainstem and meets with the same lower motor neuron supplying the upper half of the face.
- Things go similarly for the left side of the face.



Testing technique;

- Motor;

✓ Crude;

1. Ask the patient to whistle, blink, close eyes, look up while observing wrinkles of the forehead.
2. Inspect the face for asymmetry specially the nasolabial folds, the corners of the mouth, and any differences in blinking or eye closure on one side. Best observed during conversation when the patient is unaware.

✵ Note that minor facial asymmetry is common and rarely pathological.

✓ Specific;

1. Watch for spontaneous or involuntary movements.
2. Ask the patient to raise his/her eyebrows and observe for asymmetrical wrinkling of the forehead (frontalis muscle).
3. Ask the patient to screw his/her eyes tightly shut and with resist-you resist by opening them- (orbicularis oculi).
4. Ask the patient to bare his/her teeth → wide smile (orbicularis oris).
5. Ask the patient to blow out his/her cheeks with their mouth closed (buccinator and orbicularis oris), then ask them to keep this status against the pressure that you are applying on their cheeks by your hands.

- Sensory;

1. Ask the patient to close his/her eyes and protrude the tongue.
2. Take a tongue blade and smear a small amount of salt or sugar on the lateral surface and side of the tongue.
3. Ask the patient to tell you the identity of the substance.
4. Rinse the mouth thoroughly and repeat the test on the other side, using a different substance.

Abnormalities;

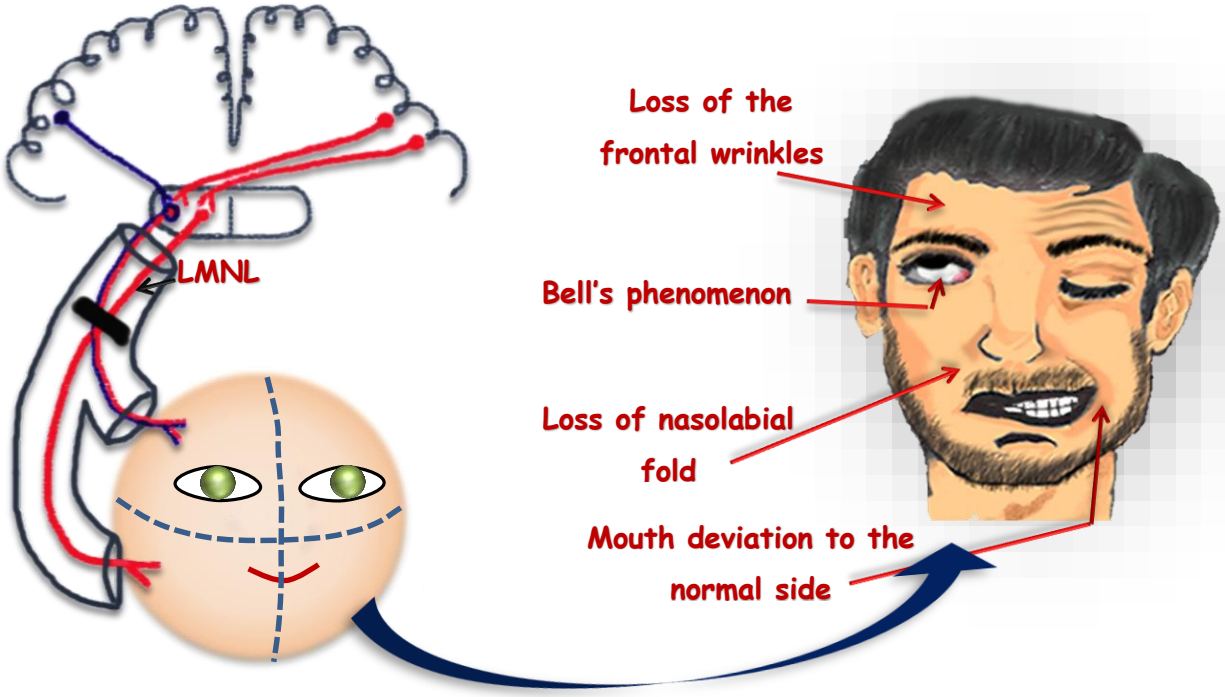
- **LMNL** and **UMNL** of facial nerve.
- LMNL; lower motor neuron lesion.
- UMNL; upper motor neuron lesion.

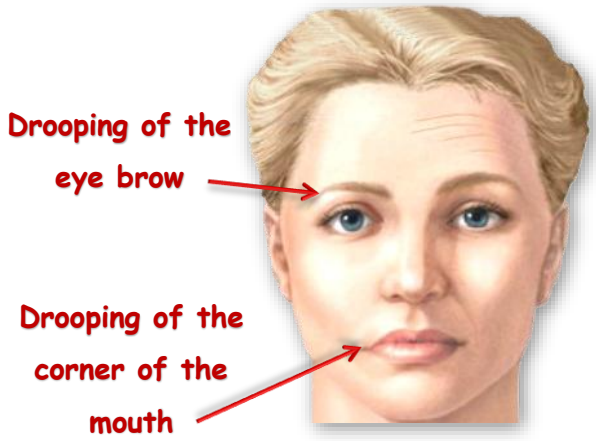
Unilateral LMN7th nerve lesion;

1. In this case, there is weakness of both upper and lower facial muscles.
2. This condition is called **Bell's palsy** when the cause is idiopathic "unknown'.
3. Often proceeded by mastoid pain.
4. Maybe associated with impairment of taste–ant 2/3–and hyperacusis (due to paralysis of stapedius muscle -the smallest muscle in the body- which controls the amplitude of sound waves to the inner ear.

- **Note**;
- ***Hyperacusis;*** high pitched sounds appearing unpleasantly louder than normal.

5. The mouth is deviated to the healthy side by the action of muscles of that side.
6. Loss of frontal wrinkles of the affected side (frontal belly of occipito-frontalis paralysis).
7. Dryness of the effected eye and mouth due to decrease secretions of lacrimal and salivary glands.
8. Loss of nasolabial fold of the affected side.
9. Inability to close the affected eye (orbicularis oculi paralysis) leading to its irritation –may lead to ulceration of cornea– and there is an upward and outward (lateral) movement of the eye when an attempt is made to close the eyes. This occurs to avoid exposure of the cornea. This is called (Bell's phenomenon).





Causes of LMNL of the 7th cranial nerve;

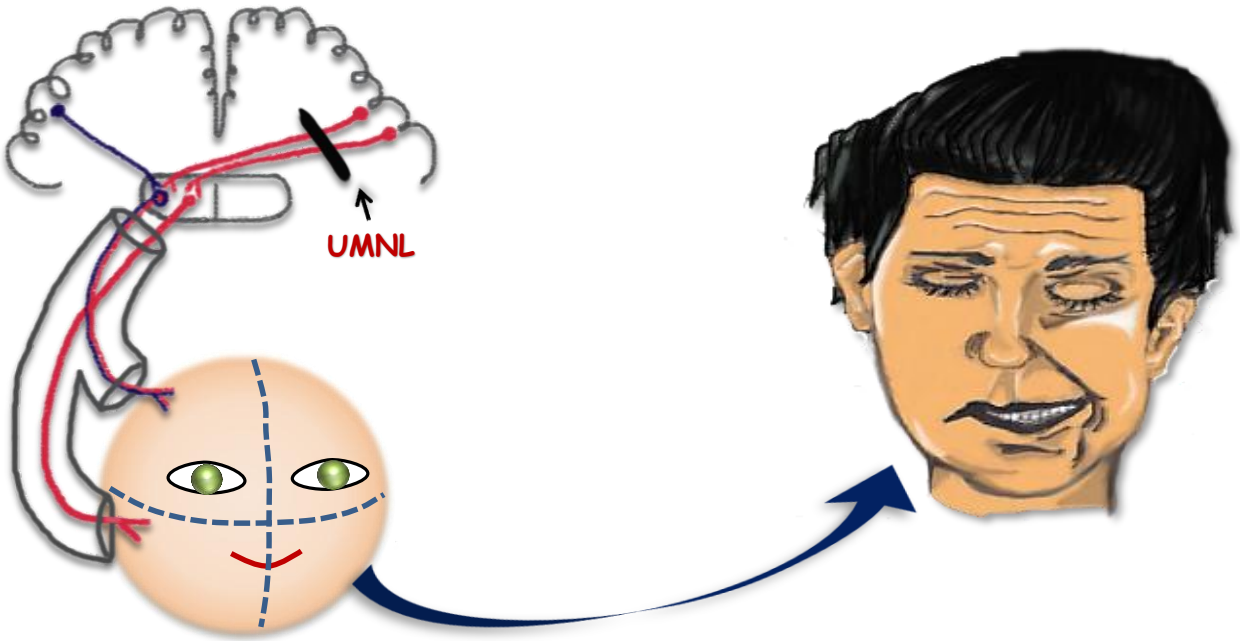
1. Cerebellopontine angle tumor.
2. Trauma.
3. Parotid tumor.
4. Ramsay Hunt syndrome (occurs in Herpes Zoster infection of the geniculate ganglion).

Note;

- Bilateral LMNLs are less common but occasionally occur as in Guillain-Barre syndrome, sarcoidosis or infections such as, Lyme disease, HIV or Leprosy.

Unilateral UMN 7th nerve lesion;

1. Weakness is marked in the lower facial muscles, with relative sparing at the upper face due to bilateral innervation of upper facial muscles but their weakness is less marked than those of the LMNL.



2. When you ask the patient to close his eyes against you opening them, you will notice that the eyelid of the affected side of UMNL appears weaker than the other and it is partially opened by your resistance.

➧ Glabellar reflex (also known as Glabellar tap sign and Myerson's sign);

- This test is elicited by repetitive tapping on the forehead.
- The person blinks in response to the first several taps.
- If the blinking persists, this is known as Myerson's sign and it is abnormal and a sign of frontal disorders.
- It is often seen in people who have Parkinson's disease, and people with Dementia.
- **The afferent**; Trigeminal nerve (V).
- **The efferent**; Facial nerve (VII).

VIII. Vestibulocochlear nerve;

Type and function;

It is a sensory nerve with two components;

Vestibulocochlear

The vestibular component;
- Supplies the vestibular apparatus which is essential for balance mechanism.

The cochlear component;
- Supplies the cochlea which houses the hearing organ.

Testing mechanism;

Testing the vestibular component mechanism;

1st you should note;

1. The patient may have already complained of; dizziness, nausea or loss of balance.
2. Part of the balance assessment is also checked by observing the posture and gait in the assessment of the cerebellar function and the motor system.
3. Also during the assessment of the eyes you may have noticed the presence of nystagmus.

Tests;

1. Hall Picks maneuver (wasn't mentioned by Dr.Mohammed**);**

a) Position the patient on the examination couch in upright position close to the end of the couch.

b) Get him to lie horizontally, The head will extent back over the edge of the couch.

c) Explain the procedures to the patient, you should inform him that the test should be rapid.
d) Get him to lie horizontally allowing his head to hang over the edge then turn the head to one side and tell him to fix his eyes on an object for a few seconds.
e) When the patient is in this position, check his eyes for nystagmus.
f) At the end ask if he experiences any undue dizziness and ask him to keep his eyes open.
g) If the nystagmus is present, note the latency (time to onset), direction, duration and fatigue (decrease on repeating the maneuver).
h) Repeat the test, turning the patient's head to the other side.

2. Caloric testing;

- It is done by introducing cold and warm water in the external auditory meatus and noticing the eye for nystagmus.

Testing the cochlear (hearing) component mechanism;

1. Whispered voice test;

- The purpose of this examination is to detect conductive and neurosensory hearing loss;

a. Stand behind the patient 15cm.
b. Ask the patient to mask his ear that will not be tested by moving the tragus in a circular motion by his index finger or just by occluding it by the tragus.
c. Ask the patient to repeat after you a combination of multisyllable numbers and words. Strat with normal voice to confirm that the patient understands the test. Then lower your voice to a clear whisper.
d. Repeat the test with the other ear.
e. Repeat the test but this time at arm's length from the patient's ear. People with normal hearing can repeat the words whispered at 60cm.

2. A simple but **crude** method of getting an initial impression of the patient's hearing in to wrap your fingers/or two pieces of paper together from some distance to see of you can both hear it.

3. Tuning fork tests (**specific**);

Weber's test — Rinne's test

- These two tests are commonly used to assess for conductive or neurosensory deafness.
- The tuning fork used is of 512Hz frequency.

Weber's test (forehead);

1. Strike the prongs of the tuning fork against a hard surface to make it vibrate.
2. Place the base of the vibrating tuning fork in the middle of the patient's forehead.
3. Ask the patient; where do you hear the sound? Central, right or left?
4. Record which said, Weber's test lateralizes (move to one side) to, if not central.

- In patients with normal hearing, the noise is heard centrally or equally in both ears.
- In conductive hearing loss, the sound is heard louder in the affected ear (magnified by pressure).
- In unilateral neurosensory deafness. It is heard louder in the unaffected ear.
- If there is symmetrical deafness, it will be heard in the middle.

Rinne's test (mastoid + ear);

1. Strike the prongs of the tuning fork against a hard surface to make it vibrate.
2. Place the vibrating tuning fork on the mastoid process (bone conductance).
3. Now bring the prongs of the still vibrating tuning fork near the external auditory meatus. And ask the patient (is it louder infront of your ear or behind (on the mastoid?)

With normal hearing;

- The sound is louder when the tuning fork in at the ext. auditory meatus (air conduction). This called positive Rinne's test, in which air conductance is greater than bone conductance - prolongs for up to 15 seconds more (AC > BC).

With conductive deafness;

- Bone conducting is better than air conduction (BC > AC) → Negative Rinne's test.

The bone conduction loss often indicates the sensory hearing loss.

False negative-Rinne's when;

- If there is a unilateral sensory hear loss the waves are transmitted to the opposite side (transcranial transmission) which is normal. This makes the patient thinks that he heard it by the affected ear, but actually he cannot. Thus, Weber's test is more accurate and more favorable.

IX. Glossopharyngeal nerve (IX).
X. Vagus nerve[4] (X).
XI. Hypoglossal nerve (XI).

- These 3 cranial nerves are normally tested together, because of their close association in the terms of origin and function.
- Their nuclei are in the medulla oblongata and they supply mostly areas of the mouth, pharynx and larynx.

- The glossopharyngeal nerve (IX);
- Supplies;

1. The post 1/3 of tongue with taste sensation. Remember! The ant.2/3 by the 7th (VII) n.
2. Mucous membrane of the tonsillar fossa.
3. Motor to styloglossal muscle.
4. Its parasympathetic component supplies the parotid gland for saliva production.
5. Baroreceptors in the carotid sinus and chemoreceptors in the carotid bodies.
6. Posterior portion of ear drum + ear canal.

- The vagus nerve (X);
- Supplies;

1. Tympanic membrane + external auditory structures.
2. Baroreceptors and chemoreceptors of aorta.
3. The many visceral structures in the thorax, abdomen; up to the transverse colon.
4. Motor to muscles of the palate, pharynx and the larynx.

- Hypoglossal nerve (XI);
- Has no sensory function.
- It supplies the intrinsic muscles of the tongue (motor).

Testing technique;

The glossopharyngeal and vagus nerves are tested together;

1. Start by asking the patient to swallow (this is a very simple (crude) test of the pharynx and larynx).
2. Notice the patient's speaking and ask him to say the letters AEIOU, these require the movement of the palate and if there is cranial nerve lesion they come out slurred.

[4] *Frequently asked about in exams.*

3. Now, look at the movement of the palate, when the patient says 'Aaaa', you will need a torch and tongue blade (depressor). The tonsillar arches should rise equally and the uvula must stay in the midline.
4. If the uvula elevated and deviated to one side, this side signifies the **stronger** side, therefore, the opposite side is affected by the weakness of these palatal muscles due to lesion of the cranial nerves supplying this side.
5. Ask the patient to puff out his cheeks with their lips tightly closed. Listen for air escaping from the nose. For the cheeks to puff out, the palate must elevate and occlude the nasolarynx. If the palate movement is week, air will escape through the nose.
6. Ask the patient to cough, assess the strength of the cough.
7. Test the pharyngeal sensation and the **gag reflex** (these are unpleasant testing for the patient);

- For this test you will need a tongue blade and ear cotton swab or another tongue blade. Touch each side of the posterior pharyngeal wall, just behind the tonsillar pillars.
- Observe the elevation of the uvula and the fossae.

- With the gag reflex, we are testing the **glossopharyngeal** nerve as the **afferent** component and the **vagus** nerve as the **efferent** component.
- Gag reflex should be tested regularly to CNS and CVA (**c**erebro**v**ascular **a**ccident) patients before they are allowed to take food orally. If not, they are subjected to aspiration pneumonia.

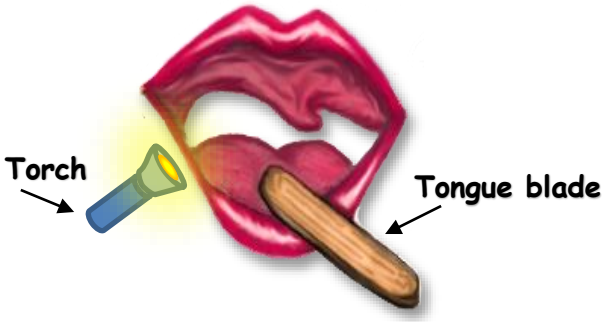
The hypoglossal nerve assessment;

1. Ask the patient to open his mouth and observe the passively resting tongue on the floor of the mouth.
2. Examine the color, size symmetry and look for an evidence for wasting.
3. Observe the presence of involuntary movement. Such as fasciculations.

- Large tongue may indicate;
  - Aoromegaly.
  - Down's syndrome.
  - Congenital hypothyroidism.
  - Amyloidosis.

- Small or unilateral wasted tongue with fasciculations;
  - LMNL.

4. Then, ask the patient to protrude his tongue, check its shape, symmetry, and evidence for fasciculations or deviation.
5. If there is deviation, then the stronger side will push the tongue towards the **weak** side.
6. Assess the strength of the tongue by asking the patient to push his tongue against the inside of his cheeks while you palpate its strength from the outside.



Asymmetry elevation of the palate and deviation of uvula towards the normal side

Wasting of the tongue

Gag reflex

Deviated tongue

XII. Spinal accessory nerve;

Type and function;

It is a motor nerve responsible for suppling the upper part of trapezius and sternocleido-mastoid muscles.

- Upper part of trapezius;
  - Elevation of the shoulder (shrugging).
  - Elevation of the arm above the horizontal.

- Sternocleidomastoid muscle;
  - Turning and flexion of the neck.

Testing technique;

1. Face the patient and inspect the sternocleidomastoid muscles for atrophy, wasting or hypertrophy. Palpate them to assess their bulk.
2. Stand behind the patient to inspect the trapezius muscle for wasting or asymmetry.
3. Ask the patient to shrug shoulders, then apply downward pressure with your hands to assess the power.
4. Test power in the left sternocleidomastoid by asking the patient turn his head to the right while you are providing resistance with your hand placed on the right side of the patient chin. Reverse the procedure to check the right sternocleidomastoid.
5. Test both sternocleidomastoid muscles simultaneously by asking the patient to flex his neck, apply your palm to the forehead as resistance.

Motor system examination

Anatomy of motor pathway;

The principle motor pathway has;

1. CNS component;
   - The corticospinal (pyramidal) tract (UMN) and the anterior horn cells (LMN).
2. PNS components;
   - The fibers of the anterior horn cells (LMN).

It also includes other parts of the nervous system, such as; **Basal ganglia (nuclei)** and **cerebellum** as they have important modulating effects on movement.

It is important to distinguish upper from lower motor neuron signs to help localize the lesion.

Examination of motor system;

- Inspection
  - 1) State of muscle.
  - 2) Involuntary movement.
  - 3) Tropic changes.
  - 4) Skeletal deformities.
  - 5) Position.
- Palpation
  - 1) Muscle tone.
  - 2) Muscle power.
  - 3) Reflexes.
  - 4) Pronator drift.

Inspection;

1. State of muscle;

- Look for any hypertrophy or atrophy (wasting).

The hypertrophy is of two types;

	True	***Pseudo***
Features	1. Increase bulk.	1. Increase bulk.
	2. Increase power.	2.Decrease power.
	3. Normal (in athletes).	3.Abnormal (in myopathy).

- The atrophy;
  - wasting away of muscles is often caused by several common diseases, such as cancer, diabetes and renal failure which affects the LMN.
  - Signs; prominence of bony prominences, shiny shaft of tibia.

2. Involuntary movement;

- Fasciculations;
  - Visible spontaneous irregular contractions of a group of muscle fibers.
  - It is visible for the doctor, not felt.
  - It is elicited by tapping the muscle.
- Causes;
- Physiological; in claves, fatigue, anxiety & caffeine (often orbicularis oculi).
- Pathological; (irritation of AHC; ant. horn cells) in motor neuron disease, poliomyelitis, cervical spondylosis.
- Look for it in; deltoid – pectoralis major – quadriceps.

- Tremor;
  - Involuntary, oscillatory movement about a joint or a group of joints resulting from alternating contraction and relaxation of muscles.
  - Tremors are classified according to their frequency, amplitude, position (at rest, on posture or movement) and body part affected.
  - We usually focus on the classification according to position.

- A physiological tremor is;

a. Fine (low amplitude).
b. Fast (high frequency 3-30 Hz).
c. Postural (position).

- Tremor in parkinsonism;
  - Is worse at rest (position).
  - Slow (low frequency 3-7 Hz).
  - More common in the upper limbs.
  - Asymmetrical and doesn't affect the head.

- Intention tremor (kinetic);
  - Absent at rest but maximal on movement (kinetic).
  - It is usually due to cerebellar damage.
  - It is assessed with the finger-to-nose test.

☒ Essential tremor;

- It is the most common pathological case of tremors.
- It is symmetrical in the upper limbs and may involve the head and larynx (voice).
- It is noted on posture and with movement (kinetic).

☒ Chorea;

- Brief, jerky random, **semipurposable**, unpredicted body movement.
- The term chorea is derived from a Greek word means (dance) as the quick movements of the feet or hands are comparable to dance.
- Example of this movement is the movement of the hand which make the others think that the patient wants to touch his/her hair, face or anything as purposable movement where it is not.
- The chorea is seen with Huntington's disease patients (see molecular biology).
- Also seen in UMNL and maybe due to putamen ganglion lesion by autoimmune response caused by acute rheumatic fever.

☒ Dystonia;

- Caused by sustained muscle contraction, leading to twisting and repetitive movement or abnormal fixed posture.
- It is believed to be caused by a disorder in the basal ganglia which are responsible for control and maintain coordinated movement such as walking. While preventing unwanted or un-necessary movement at the same time.

☒ Athetosis.

☒ Ballism.

- Read any clinical book or search for them in the internet if you want to know about them.

☒ Fibrillation;

- Spontaneous contraction of a single muscle fiber.
- Seen only in the tongue.
- Indicates AHC irritation.

3. Trophic changes;

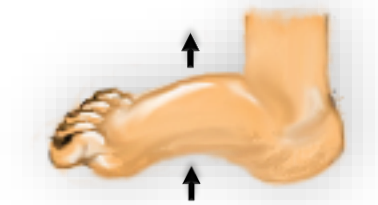
- Indicates LMNL.
- Due to loss of trophic impulses from ANH and loss of muscle tone.
- These changes are;
- Trophic ulcers.

- Coldness.
- Dry skin.
- Loss of hair.
- Brittle nails.

4. Skeletal deformities;

☒ Pes cavus;

- Exaggerated arch of the foot.
- Maybe;



Congenital	Acquired
- Short big toe. - Hammer toe (contracted).	- Big toe is larger than the adjacent one.

☒ Pes planus;

- Low-arched foot (flat foot).
- Common foot deformity.
- Loss of medial longitudinal arch of the foot.
- It is maybe;

➢ Congenital

- Common in infants (physiological), most children develop normal arches by age 5 or 6 years.
- There is a small percentage of children who fail to develop normal arches by adulthood.

➢ Acquired;

- It most commonly occurs secondary to tibialis posterior tendon dysfunction.
- Maybe caused by trauma to midfoot.

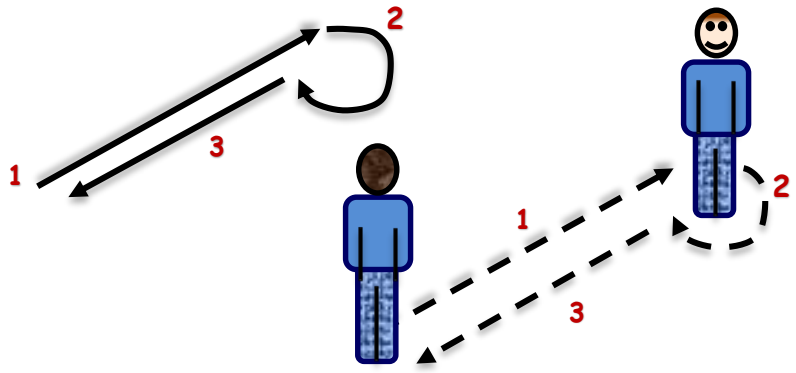
☒ Clawing of toe;

- The toe is contracted at the proximal and distal interphalangeal joints.
- Can lead to severe pressure and pain.
- Can affect any toe except the big toe.
- Causes;
- It is often the result of nerve damage caused by disease like diabetes or alcoholism, which can weaken the muscles that are responsible for dorsiflexion of the toes.

5. Position (gait);

Technique of assessment;

1. Look at the patient's shoes for abnormal wearing pattern.
2. Ask the patient to walk away from you, about 5 – 10 feet, turn through 180° then return.



3. Ask the patient to walk as before but he now should keep walking on his tiptoes (testing plantiflexion).
4. Ask him to do the same thing but now with his heels (testing dorsiflexion).
5. Ask him to walk heel to toe (tandem gait) on an imaginary line or even draw it on the floor (testing gait ataxia).

Why you should test the gait?

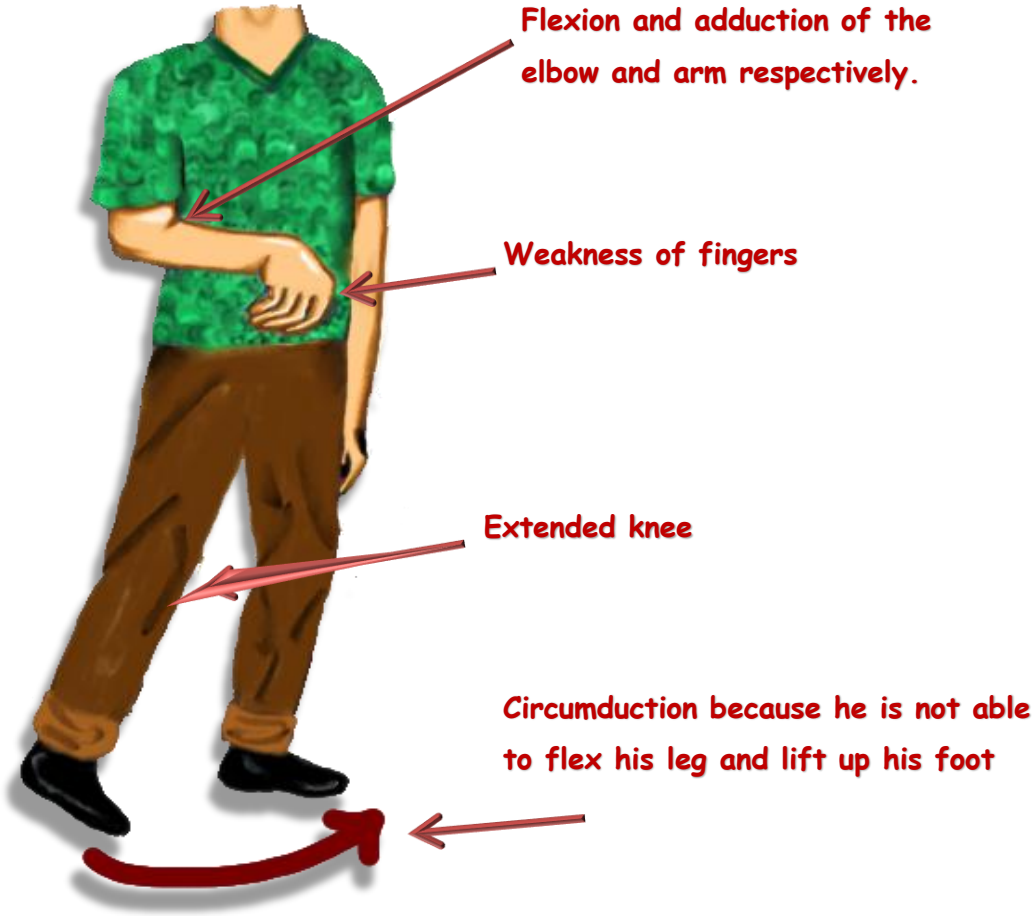
- It will be a great shame for a patient to come with an abnormal gait and for us to send him/her for testing or consultation when the diagnosis may be fairly evident in the gait!

The common types of gaits;

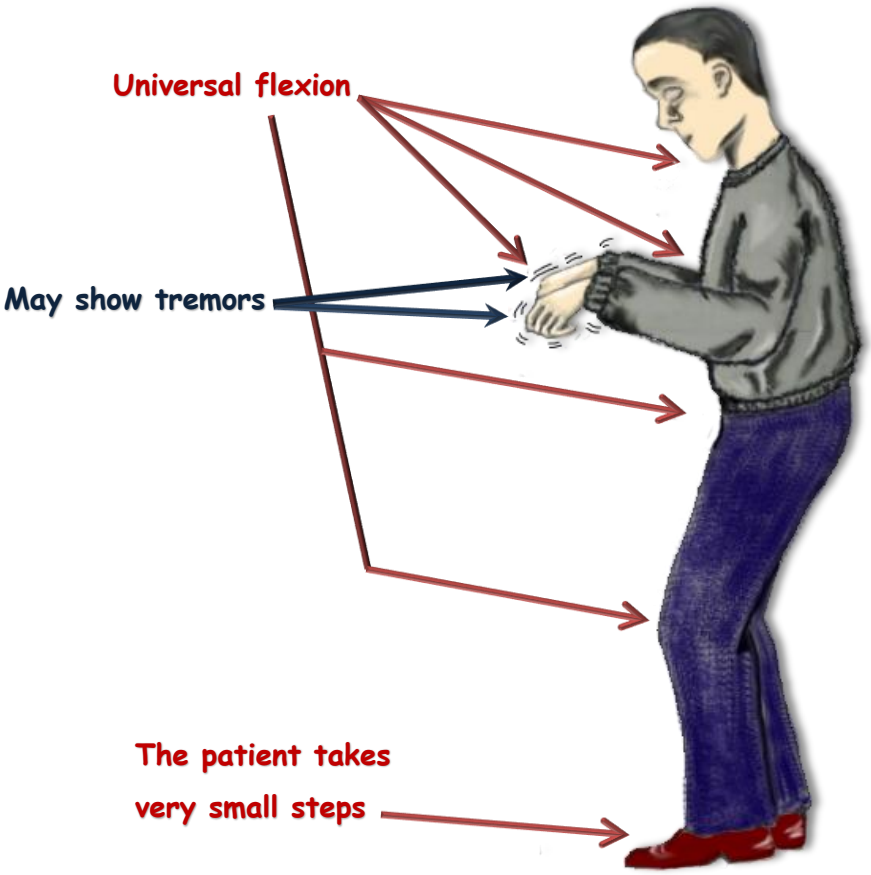
Hemiplegic gaits (the most common);

- The patient stands with unilateral weakness on the affected side.
- It is due lesion of the pyramidal tract of the opposite side.
- The patient develops flexors hypertonia in the upper limb (elbow) and extensors hypertonia in the lower limb (knee).
- Arm → flexed, adducted and rotated internally.
- Leg → extended.
- Foot and toes → planter flexion (dropping).
- The patient will hold dis arm to one side and drag his leg in a semicircle (circumduction).
- These singes are due to hypertonia proximally and weakness of distal muscles so you will notice the weakness of hand, fingers, feet and toes.

- There is a loss of swinging of the normal arm.


Flexion and adduction of the elbow and arm respectively.
Weakness of fingers
Extended knee
Circumduction because he is not able to flex his leg and lift up his foot

- Parkinsonian gait;
- Is the gait of the patient with Parkinson's disease.
- It is the posture that is characterized by the universal flexion, i.e; the joints are flexed and the patient is typically taking very small steps which are called festination as they are accelerating steps.
- The patient also may walk with slow little steps known as **marche a petits pas**.
- Patient may also have difficulty initiating steps.
- The patient will have rigidity and bradykinesia.



- Cerebellar or Ataxic gait;
- It is characterized by a broad stand and by a wide staggering quality of movement.
- Patients will tend to fall toward the side of the illness so if the illness is in the left, they may fall in that direction.
- When they stand still the patient's body (trunk) may swagger back and forth and from side to side. This is known as (tituba-tion).
- Patients with more truncal instability are more likely to have a midline cerebellar dis-ease of the vermis.
- The gait of alcohol intoxication will resem-ble the gait of cerebellar disease.

Wide based gait

Standing still

Cerebellar gait

Standing still

Normal

- Sensory ataxia gait;
- Many people think that the Romberg's test has been a test for a cerebellar disease while it is not. The Romberg's test has nothing to do with the cerebellum because the cerebellar patient is already swaying and he gets more swaying when he closes his eyes. In fact, the Romberg's test is a test of proprioception.
- As our feet touch the ground and we are in a standing position we receive proprioceptive information to tell us their location as well as visual information when our eyes are opened.
- The sensory ataxic gait occurs when there is loss of the proprioceptive input, the patient will rely on his eyes to tell him where he is in the space and therefore, the moment you ask the patient to close his eyes while standing, the patient begins to sway and that is a +ve Romberg's test.
- For the patient in order to know whether his foot is alright on the floor, and he is relying on his visual information, especially in the dark, he may develop what is called (**stomping** or **stamping gait**).
- The patient will slam the foot hard onto the ground to get the vibration into his trunk to know that his foot has landed.
- A key to this gait involves;
- Its exacerbation when patients cannot see their feet (in the dark).
- It is not evident in the daytime because he can see where he is going.

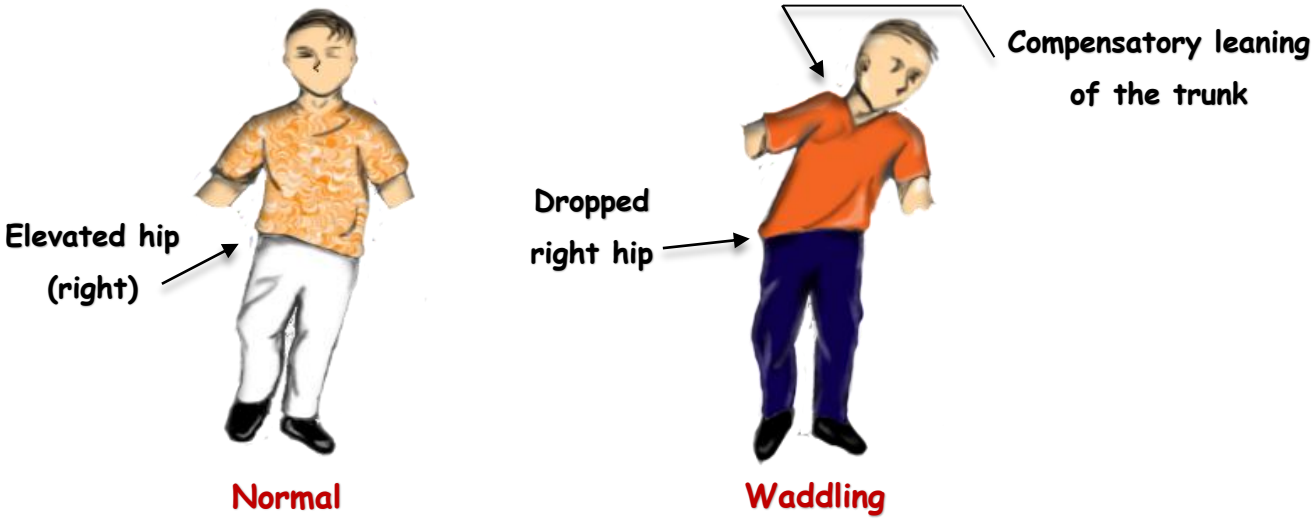
- Diplegic gait = the cerebral palsy gait;
- This gait is seen often in children and in adults affected by this from childhood.
- Typically, the patient has an extensors spasm and almost they keep walking on tiptoes.

- Although they have some circumduction, they have a lot of adduction so they walk with an abnormally narrow base, dragging both legs and scraping the toes.
- Patients have involvement on both sides with spasticity in lower extremities worse than upper extremities.
- They have a characteristic extreme tightness of hip adductors which can cause legs to cross the midline → scissors gait.
- In countries with adequate medical care, patients with cerebellar palsy may have hip adductors surgery to minimize scissoring.

Myopathic gait or Waddling gait;

Normally, when you take a step forward, the hip in the side where you are stepping forward, will actually move up and you have a very strong pelvic girdle muscles on that side, this allows you to take that step.

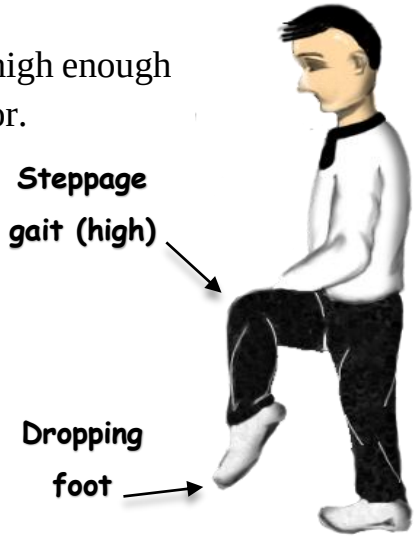
- If the patient has a myopathy, when he lifts his leg up to take a step, because he cannot hold his pelvis and stabilize it, there is a tendency for the hip to fall in that side and he will fall over! And to compensate that he will lean his trunk to the opposite side, so he will develop a Waddling gait.
- So, if he has a weakness on one side, this will lead his pelvis to drop on the contralateral side (healthy side) while walking (Trendelenburg sign).



Neuropathic gait (Steppage-Equine gait);

- If a patient has a peripheral neuropathy and he has a foot drop, then typically he has had a high stepping gait.
- The dropping foot is due to weakness of foot dorsiflexors.

- The cause of this gait, is due to an attempt to lift the leg high enough during walking so that the foot does not drag on the floor.



- If unilateral, causes include;
- Peroneal nerve palsy.
- L5 radiculopathy.
- If bilateral the causes may include;
- Amyotophic lateral sclerosis.
- Charcot-Marie-Tooth disease.
- Uncontrolled diabetes mellitus.

Palpitation;

1. Upper limb;

✓ Examine for pronator drift;

- Ask the patient to extend his arms forward with the palms facing upward, and hold them in this position for at least 15 seconds with the eyes closed.
- If the pronator drift is present, the patient's hand will pronate and his arm will drift downward.
- This test is of high sensitivity for detecting weakness due to motor lesions in the corticospinal tract.

✓ Check tone;

- **Note;** shaking hands with the patient can be a crude method to inspect for myotonia (inability to relax muscles after voluntary contraction).
- Tone is the amount of residual resistance offered by a muscle when it is moved passively.
- Assess tone in the upper limb by rotating the wrist, flexing and extending the elbow.
- Feel for constant stiffness which indicates **rigidity**.

Rigidity;

- Def.; is constant increased tone that is velocity independent.
- Cause; upper motor neuron lesion UMNL in extrapyramidal tracts.
- Other names; Alpha rigidity or lead pipe rigidity.
- Usually associated with; hyporeflexia.
- Also seen in; parkinsonism.

- Feel for catching which indicates **spasticity**.

Spasticity;

- Def.; increased tone that is velocity dependent.
- Cause; UMNL in the pyramidal tract.
- Other names; Gamma rigidity or clasp knife rigidity.
- Usually associated with; hyperreflexia and clonus.

- Feel for decreased tone which indicates **flaccidity**.

Flaccidity;

- Def.; abnormal decreased muscle tone.
- Cause; LMNL.

✓ Check power;

- When assessing muscle power use MRC scale (medical research council) to quantify your finding.

Grade 5 (normal);

- Normal strength against full resistance.

Grade 4;

- Muscle strength is reduced but can still move joint against resistance, and can be further broken down into;

a. 4+ → strong resistance.
b. 4 → moderate resistance.
c. 4- → slight resistance.

Grade 3;

- Movement only against gravity, with resistance completely removed.

Grade 2;

- Muscle can move only if gravity is removed (not against gravity).

Grade 1;

- Is a flicker of movement seen or felt in muscle, or fasciculations are observed.

Grade 0;

- No movement at all.

- To test muscle power, use a systemic approach. Neurologists usually like to test proximal to distal.

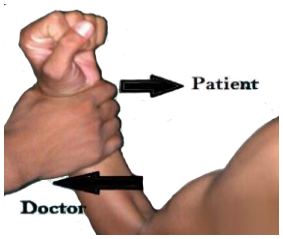
We focus on a few key muscles as following;

- Shoulder abduction.
- Elbow flexion/extension.
- Wrist extension/flexion.
- Fingers extension/flexion.
- Fingers abduction/adduction.
- Thumb abduction.
- Thumb opposing against other fingers.

1- Shoulder abduction;

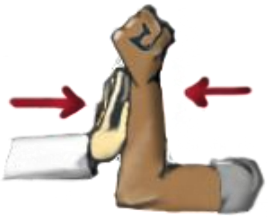
- Muscles; deltoid muscle.
- Nerve; axillary nerve C5, C6.
- Procedures; ask the patient to abduct his shoulders and flex his elbows and prevent you from lowering them.

2- Elbow flexion;



- Muscles; biceps muscle.
- Nerve; musculocutaneous nerve C5, C6.
- Procedures; ask the patient to flex his elbow against your resistance (prevent you from extending them).

3- Elbow extension;



- Muscles; triceps muscle.
- Nerve; radial nerve C6, C7, C8.
- Procedures; ask the patient to extend his elbow against your resistance.

4- Wrist extension (dorsiflexion);

- Muscles; wrist extensor muscles.
- Nerve; radial nerve C6, C7, C8.
- Procedures; test the extensor muscles power by asking the patient to extend his wrist and prevent you from flexing it.

5- Wrist flexion;

- Muscles; flexor carpi radialis, flexor carpi ulnaris.
- Nerve; median nerve C6, C7 & ulnar nerve C7, C8, T1.
- Procedure; test the power of the flexors of the wrist by asking the patient to flex his wrist against your resistance.

6- Fingers extension;

- Muscles; Finger extensor muscles.
- Nerve; C7, C8 radial nerve.
- Procedure; ask the patient to straighten his fingers and prevent you from bending them (push with the side of your hand against metacarpophalangeal joints).

7- Fingers flexion;

- Muscles; finger flexor muscles.
- Nerve; median/ulnar nerves C7, C8.
- Procedure; test the finger flexors power by applying resistance against the patient's flexed fingers.

8- Fingers abduction;

- Muscles; 1st dorsal interosseous and abductor digital minimi.
- Nerve; ulnar nerve C8, T1.
- Procedures; when testing finger abduction, it is preferred to use your index and pinky fingers to apply pressure (resistance).

9- Fingers adduction;

- Muscles; palmar interossei.
- Nerve; ulnar nerve C8, T1.
- Procedure; ask the patient to hold his fingers together and prevent you from separating them.

10- Thumb abduction;

- Muscles; abductor pollicis brevis.
- Nerve; median nerve C8, T1.
- Procedure; to test this muscle power ask the patient to get his thumb in and upward and use your thumb to apply pressure (push the patient's thumb forward and inward.

Note; the thumb abduction will often be weak in carpal tunnel syndrome.

11- Thumb opposition;

- Muscles; opponens pollicis.
- Nerve; median nerve C8, T1.
- Procedure; ask the patient to oppose his thumb against other fingers and prevent you from separating it from the opposing fingers.

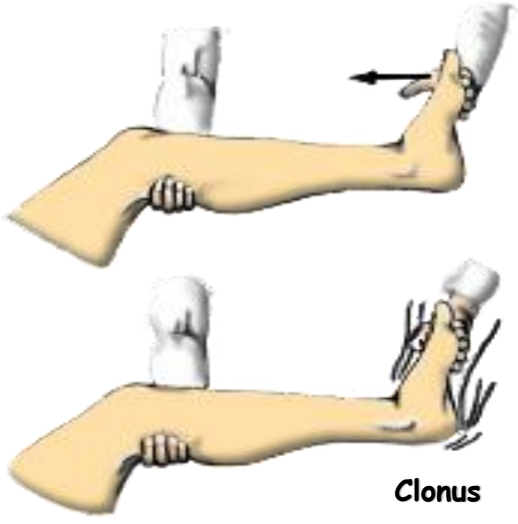
2. Lower limb

✓ Check tone;

- To assess the tone of LL;
- First, roll the limbs back and forth.
- Next, lift the patient's leg up from the knee, first slowly then quickly.
- As the tone of UL, feel for rigidity, spasticity, and fasciculations.
- Now examine the ankle and patellar clonus;

To elicit ankle clonus;

- support the patient's leg, with both the knee and ankle resting in 90 flexion.
- Briskly dorsiflex and partially evert the foot sustaining the pressure (do not leave the hand after dorsiflexing).
- The foot should not be resting on the bed surface when eliciting ankle clonus.



Eliciting Ankle Clonus

Clonus

To elicit patellar clonus;

- The leg should be extended and relaxed.
- Grasp the patella between index and thumb fingers and execute a sudden, sharp, downward thrust, holding downward pressure at the end of the movement.

Eliciting patellar Clonus

- Few beats of clonus can be normal finding.

✓ Check power;

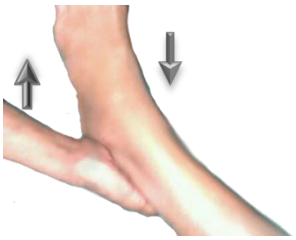
- Hip flexion/extension.
- Hip adduction/abduction.
- Knee flexion/extension.
- Ankle dorsiflexion/planter flexion.
- Ankle inversion/eversion.

1- Hip flexion;

- Muscles; iliopsoas muscle.
- Nerve; femoral nerve L1,2,3.
- Procedures; while the patient is lying on the couch test the iliopsoas power by asking him to flex his thigh and hold it flexed against your resistance.

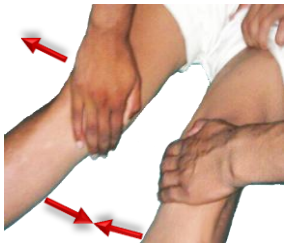
2- Hip extension;

- Muscles; gluteus maximus muscle.
- Nerve; inferior gluteal nerve L5, S1,2.
- Procedures; while the patient is laying on the couch ask him to keep his heel on the bed against your resistance.



3- Hip adduction;

- Muscles; hip adductor muscles.
- Nerve; obturator nerve L2,3,4.
- Procedures; ask the patient to flex his knee slightly while he is laying on the couch to push in against your resistance.



4- Hip abduction;

- Muscles; gluteus medius, minimus and tensor fascia lata.
- Nerve; superior gluteal nerve L4,5, S1.
- Procedure; ask the patient to keep his knees flexed slightly as previously and push out (laterally) against your resistance.

5- Knee flexion;

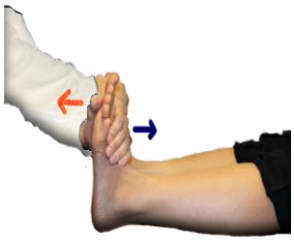
- Muscles; hamstring muscles.
- Nerve; sciatic nerve L5, S1,2.
- Procedures; ask the patient to flex his leg while you are trying to extend it by pushing the leg out with a hand and supporting the knee with the other.

6- Knee extension;

- Muscles; quadriceps femoris.
- Nerve; femoral nerve L3,4.
- Procedure; ask the patient to extend his legs against your resistance.

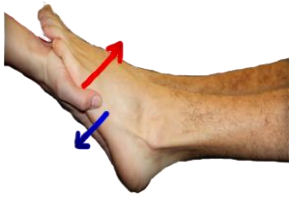
7- Ankle dorsiflexion;

- Muscles; tibialis anterior.
- Nerve; deep peroneal (fibular) nerve L4,5.
- Procedure; ask the patient to dorsiflex his foot (bringing the foot back or up) against your resistance.



8- Ankle plantiflexion;

- Muscles; gastrocnemius.
- Nerve; tibial nerve S1,2.
- Procedure; ask the patient to bring his foot down against your pressure.



9- Ankle inversion;

- Muscles; tibialis posterior.
- Nerve; tibial nerve L4,5.
- Procedure; ask the patient to bring his feet inward and hold them strong against your resistance.

10- Ankle eversion;

- Muscles; peroneus (fibularis) longus & brevis.
- Nerve; superficial fibular nerve L5, S1.
- Procedure; ask him to evert feet (bring them out) and hold them strong against your resistance.

Quick test of the lower limb power;

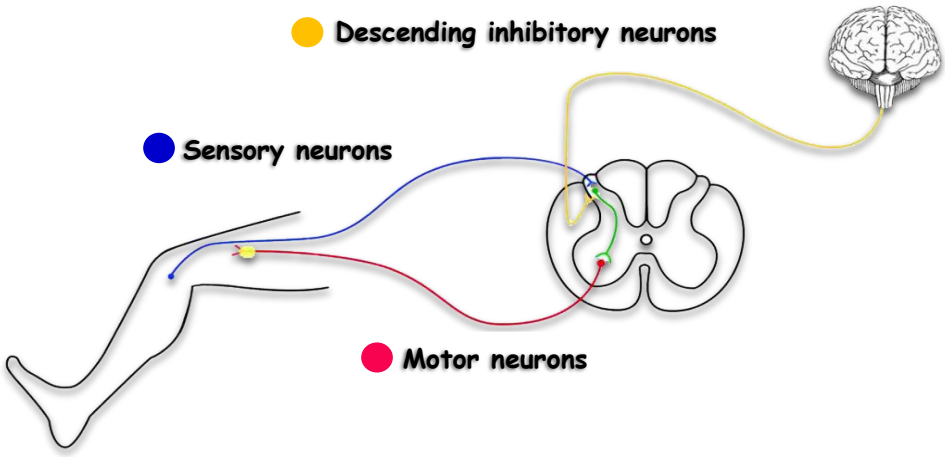
1. Stand up on toes.
2. Stand up on heels.
3. Squat then stand again.

3. Reflex exam;

Reflex exam

- Deep reflexes
  - Upper limbs (UL)
  - Lower limbs (LL)
- superficial reflexes
  - Planter (LL)
  - Abdominal

Testing reflexes is a good way to examine sensory neurons, motor neurons and descending inhibitory neurons in the spinal cord.



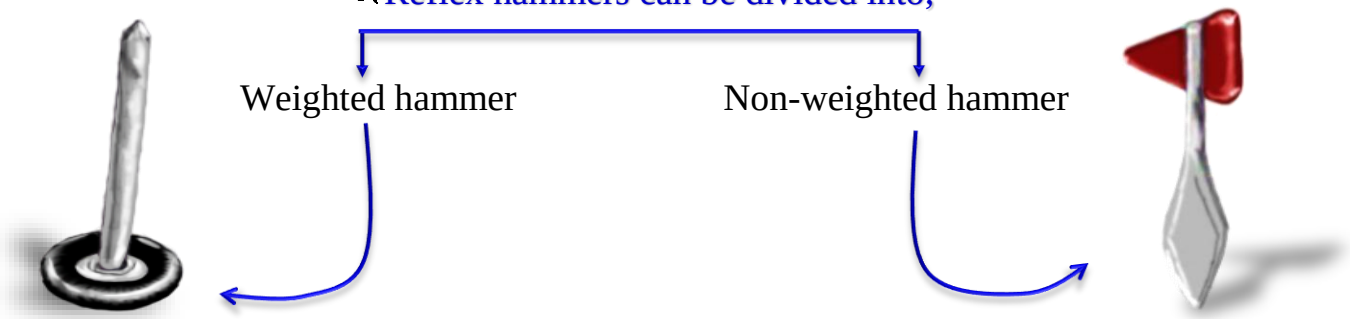
Deep tendon reflex;

- When assessing reflexes, use the deep tendon reflex grading scale to quantify your finding.
- Note that this scale is somewhat subjective and requires some experience to distinguish normal from abnormal.

- DTR grading scale (grade 0-4);

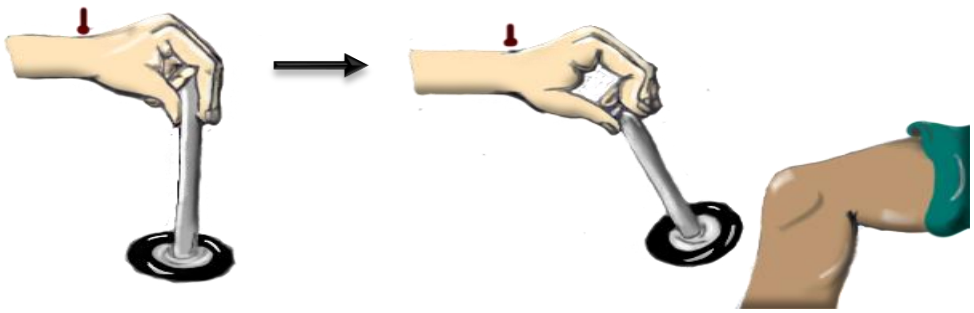
- A grade 0 reflex;
  - Is no reflex.
- A grade 1 reflex (hyporeflexia);
  - Distinguished reflex (often requires reinforcement maneuver such as the Jendrassik Maneuver).
- A grade 2 reflex;
  - Normal reflex.
- A grade 3 reflex (hyper reflexive);
  - Is pathologically brisk reflex.
- A grade 4 reflex (hyper reflexive);
  - Is pathologically brisk reflex with clonus.

Reflex hammers can be divided into;

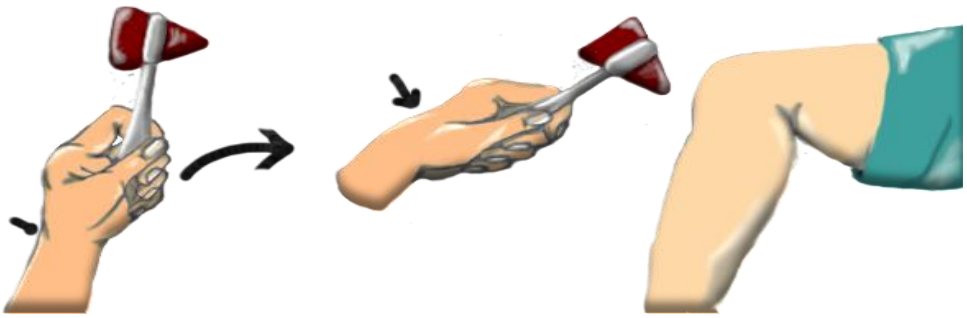


Technique of using;

1. Use the weight of the hammers and swing it like a pendulum, be sure that the wrist is fixed.



2. Use a flicking movement with your wrist.



1. Upper limb;

a) Biceps reflex (C5,6);

- feel for the biceps tendon in the cubital fossa of the patient, and apply some tension with your fingers.
- Slightly tap on your fingers by the hammer and feel for the contraction of the biceps tendon under your finger and observe for contraction of the muscle, you will see a slight flexion of elbow.

b) Brachioradialis reflex (C6);

- Feel for the brachioradialis tendon in the ant. Radial part of the forearm.
- Tap the tendon and observe for the slight wrist extension and elbow flexion.

c) Triceps reflex (C6,7);

- Support the patient's arm and feel for triceps tendon.
- Tap the triceps tendon and observe for slight elbow extension.

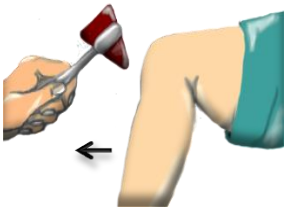
d) Finger jerk (C8);

- Place your middle and index fingers across the palmar surface of the patient's proximal phalanges.
- Tap your own fingers with the hammer.
- Observe for the slight flexion of the patient's fingers.

Notice that when applying reflex tests on some areas you should protect them by tapping on your own fingers not on the area directly, due to important structures passing beneath.

2. Lower limb;

a) Patellar reflex (L2,3,4);



- Palpate then tap the tendon (below the patella) and observe for knee extension.
- If you have difficulty eliciting the reflex, try performing the (Jendrassik maneuver) to bring on a stronger response and distracting patient's over attention; pulling with hands by flexing both sets of fingers into a hook-like form and interlocking both sets of fingers together, also clenching the teeth.

b) Achilles reflex (S1,2);

- Ask the patient to relax his leg.
- Dorsiflex the patient's foot slightly to stretch the Achilles tendon.
- Tab and observe for slight plantiflexion of the foot.

Superficial reflex;

1. Planter reflex;

- Gently scratch the sole of the patient's foot with a blunt instrument such as a key.
- Start from the lateral heel and move up along a curve to the ball of the foot in the form of inverted (L).

✓ In healthy adult;

✓ The foot inverts and the toes are drown downward, i.e; normal planter reflex;

a) Ankle inversion.

b) Downwards-going toes.

✓ Babinski's sign (positive planter reflex);

✓ The big toe will dorsiflex.

✓ The other toes will fan out.

Occurs in LMNL, infants, deep coma.

Equivocal planter reflex or absent in;

- Thick skin or cold.

- Peripheral neuropathy.
- LMNL.

Notes;

Hyperreflexia maybe due to;

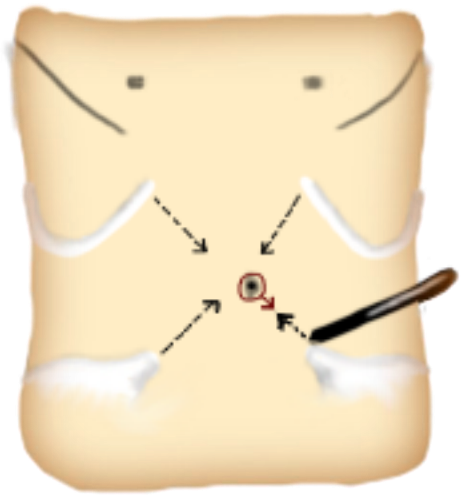
- UMNL.
- Thyrotoxication (hyperthyroidism).
- Tetany.
- Hysterical.

Hyporeflexia may be due to;

- Hypothyroidism.
- LMNL.
- Chorea.
- Cerebellar dysfunction.

2. Abdominal reflex (T7,12);

- The patient should be supine and relaxed.
- Strike the abdominal skin lightly by a pin, as an example, along a line extending from the anterior superior iliac spin toward the umbilicus or from the tip of the 9th costal cartilage toward the umbilicus.
- Do the previous step in each quadrant of the abdomen.
- Observe for the contraction of the abdominal muscles indicated by; the elevation of the umbilicus (usually toward the stimulus).



Absent abdominal reflex;

Physiologically, due to many causes;

- Obesity.
- Tolerance.
- Children.
- Multiparous lax abdominal wall (frequent pregnancy).

Pathological, in;

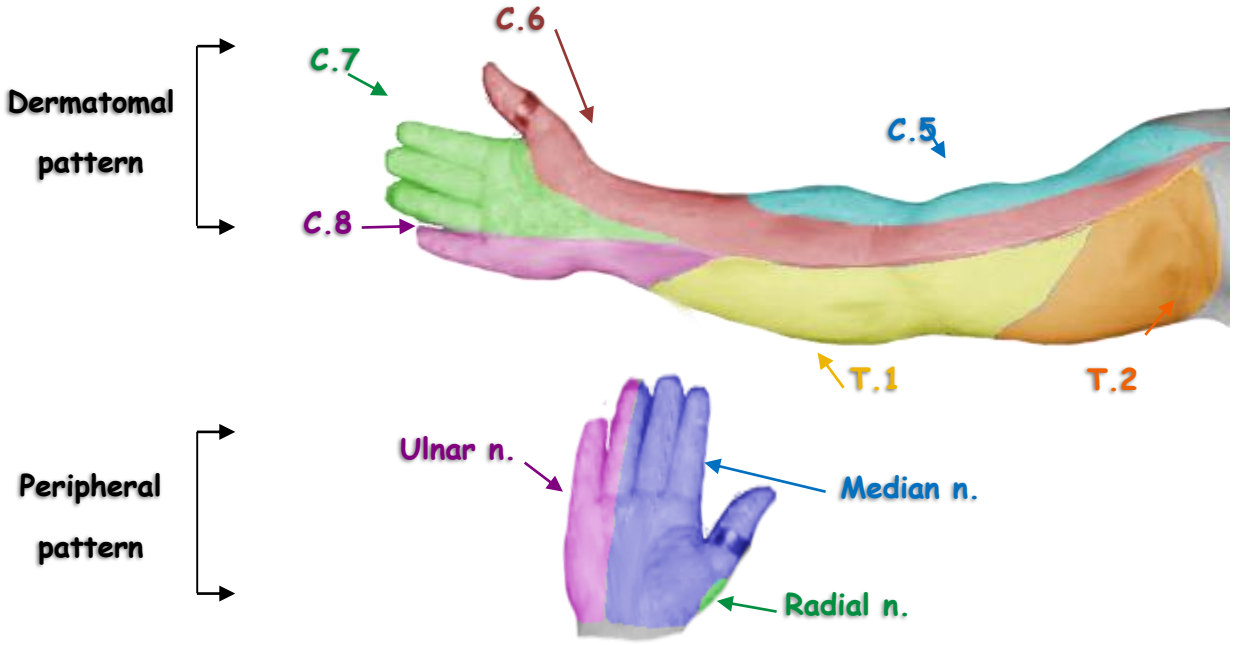
- Multiple sclerosis.
- Motor neuron disease.
- Neurogenic bladder; difficulty or full inability to pass urine without use of catheter due to dysfunction of the U.B. as a result of the CNS disease or disease of peripheral nerves.
- Brown-Sequard syndrome.

- Chiari malformation.

- Why is this reflex unfavorable and not used as much as other reflexes?
  - Because it requires uncovering of the abdomen of the patient and this is uncomfortable for some patients and the most important thing is that this reflex is not accurate as it can be absent in many physiological cases.

Sensory system examination

You must be aware of dermatomal pattern of the body as well as the peripheral nerve pattern to examine the sensation of the patient.



The clue to the dermatomal pattern which can make it simple to remember is the following;

Remember that;

- ✓ **T4** dermatome is a broad strand at the level of the **nipple**, above it the dermatomes are of lesser number to **C2** at the **neck**.
- ✓ Upper limb starts from C3 proximally to C8 distally.
- ✓ Lower limb starts from L1 proximally to S1 distally.
- ✓ T10 at the level of the umbilicus.
- ✓ T12 at the level of symphysis pubis.
- ✓ One stands on S1.
- ✓ One sits on S3.

The sensation will be tested includes;

- Temperature.
- Pain.
- Non-discriminative (crude) touch.
- Vibration.
- Proprioception (joint position).
- Tactile localization.
- 2 points discrimination.
- Graphesthesia.
- Stereognosis.

The sensations are classified into;

- Superficial;
  - Crude touch.
  - Pain.
  - Temperature.
- Deep
  - Vibration.
  - Proprioception.
- Cortical
  - Tactile discrimination; (2 points discrimination)
  - Graphesthesia.
  - Tactile localization.
  - Stereognosis.

Superficial sensation assessing;

1- Temperature;

- Test temperature sensation by applying a warmed or cooled tuning fork to the skin.

Tip;

- If needed, warm or cool your tuning fork by running it underwater.
- Do the previous step on each dermatome as possible, and according to the complain of the patient. Also, do not forget the peripheral nerve pattern.

2- Pain (the eyes should be closed);

- Assess pain by applying a sharp object such as a safety pin or broken tongue blade to the skin (assess the dermatome and the peripheral nerve pattern) and ask the patient to describe if the object applied to his skin is sharp or dull.

3- Crude (non-discriminative) touch (the eyes should be closed);

- Asses the crude touch by applying a soft object such as a cotton ball or tissue to the skin and ask the patient to tell you if he feels it.

It is important to make sure that the eyes of the patient are closed before you apply the test.

4- Assess vibration (the eyes should be closed);

- By placing a vibrating (128 Hz) tuning fork to the bony prominences while the patient is closing his eyes, and ask him if he feels the buzzing and where, then to tell you when the buzzing is stopped.

Tip;

- Stop the buzzing by touching the vibrating limbs of the fork.

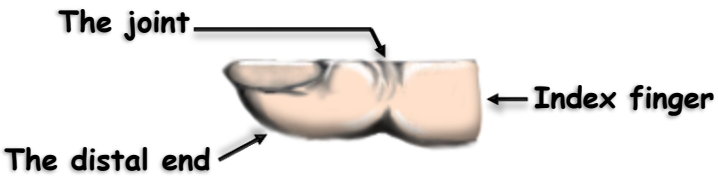
- During the test, stop the vibration putting the fork on a bony prominence and ask the patient whether he feels the buzzing or not in order to make sure that the patient does not mix the touch with the vibrant sensation.
- Make sure that the eyes of the patient are closed so the test is conducted properly.

The bony prominences you should use;

- ✓ The distal phalanges of index finger, thumb, middle finger, big toe… and so on.
- ✓ Wrist.
- ✓ Medial malleolus (L.L).
- ✓ Anterior tibial tuberosity.
- ✓ Anterior superior iliac spine.
- ✓ Spinous processes.
- ✓ Clavicles.

5- Proprioception (the eyes should be closed);

- Asses proprioception by stabilizing the joint and moving the distal end up and down, ask the patient to report what he feels.



6- Tactile discrimination;

- Assess it by using Weber compass starting by closed compass, then increasing the distance between its limbs gradually. Also, there is another tool called discriminator.

Tactile discrimination means the ability to distinguish 2 touch stimuli applied simultaneously to the skin as 2 separate points.

Steps;

- Ask the patient to close his eyes.
- Use Weber's compass or 2 pins and touch the skin simultaneously and ask the patient whether he feels one or 2 objects.
- Type the minimal distance which the patient can distinguish the 2 points by observing the Weber's compass scale or by using a ruler to measure the distance between the 2 points marked by the pins.

You should keep in your mind that the normal 2 points threshold for each area in the body like;

- The fingertip; 3mm
- The lips; 2-4 mm.
- The back; ≥ 65 mm.

The 2 points discrimination can be impaired by damage to the cuneate and gracile tracts or to the medial lemniscus.

7- Tactile localization;

- It is the ability to localize the point of the skin that had been touched.

Steps;

- Ask the patient to close his eyes.
- Touch any point in certain dermatome by a pencil -for example- and ask the patient to point to the touched point by his index finger.

8- Graphesthesia;

- Is the ability to identify a number written on the palm of the hand.
- This is another test for intact parietal lobe functioning.

To assess the graphesthesia;

- Ask the patient to close his eyes.
- Use a pin, pencil or similar object and write a number between 0 and 9 on the patient's palm, then have the patient tell you what you wrote.

9- Stereognosis;

- It is the ability to recognize the nature of an object by handing it and without using vision.

To assess it;

- Ask the patient to close his eyes and give him a key or a pin or any familiar object and ask him if he recognizes it and to tell you what it is.

Cerebellar functions test

Functions of the cerebellum

Coordination

- By; cerebellar hemispheres each controls the ipsilateral half of the body.
- In general, they are the neo-cerebellum.

Equilibrium

- By; vermis and the flocculonodular lobe.
- In general, they are the archicerebellum & paleo cerebellum.

As previously mentioned, assess the gait (see cerebellar ataxic gait) observing for nystagmus, and assess speech.

The signs of cerebellar dysfunction (from head to feet) are;

1- Scanning speech;

So if you ask the patient to say something with many consonances such as (British constitution) may say (thea Brr-idiish coun--stiitution).

2- Nystagmus;

So if you ask the patient to follow up your finger, he will have a nystagmus with **fast phase** pointing to the affected cerebellar hemisphere or to the side of disease affecting the vestibular system.

If the patient has a disease in the vermis or in the flocculonodular lobe, the patient will not be able to set up, he will have a trunk ataxia.

3- Dysmetria (see later).

4- Hypotonia.

5- Dysdiadochokinesia.

After assessing the **gait** by walking back and forth including tandem gait, and the **speech** and looking for **nystagmus**, now assess the coordination function**;**

Coordination assessing;

- ✓ Finger-to-nose / finger-to-finger test.
- ✓ Rapid alternating movement.
- ✓ Heel to shin test.
- ✓ Rebound phenomenon (of Steven and Holmes).
- ✓ Finger thumb tap.

- Coordination function is responsible for performing **smooth** movement and depend on intact sensory and motor function, and cerebellum.

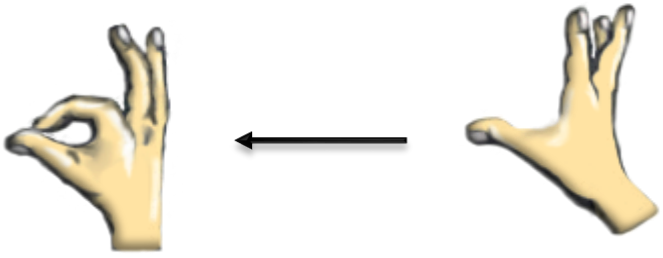
1. I / Finger-to-nose test;

- Think with me, let's say there are 17 joints in the upper limb (one) need to be moved to do this movement (14 of the fingers, 1 of the wrist, 1 of the elbow and 1 of the shoulder). There is a sensory proprioceptive input, intact motor out-put and cerebellum which receives information from the input and coordinates the motor out-put to perform the smooth movement, what a wonderful function! so now I think it is clear why we do these tests for assessing coordination.
- Steps;
  - Ask the patient to touch his nose with the tip of their index finger and then fully extend the arm away, ask him to repeat this movement as quickly as possible.
  - Ask the patient to touch his nose with the tip of his index finger and to touch your fingertip. Hold your finger at the extreme of the patient's reach (you should make the patient use the arm outstretched), ask him to repeat as quickly as possible.
  - Make the test more sensitive by changing the position of your target finger**. Move your finger just as the patient's finger is about to leave his nose** (otherwise you will induce a false-positive finger-to-nose ataxia).
- In all previous steps, look closely in **Accuracy** of the patient's finger and for presence of **intention tremor.**
- Note; some patients are so ataxic that they may injure their eye, face with this test. If so, use your both hands as the target or ask the patient to touch his chin rather than nose.

1. II / Finger-to-finger test;

- Ask the patient to fully extend both his arms and to meet his both index fingers together.
- Again! look at the **accuracy** of the patient's fingers and to intention tremors.

2. Finger thumb tap;



- Ask the patient to take his index finger and tap by it on the crease of the thumb as quickly as possible.
- Look for; **rate**, **rhythm**, **amplitude** and **accuracy**.

3. Rapid alternating movement;

- Ask the patient to place one hand over the dorsum of the other hand and have him flip one hand back and forth as fast as possible.

Again! look for; **rate**, **rhythm**, **amplitude** and **accuracy**.

Ataxia makes this movement difficult, producing a slower, more irregular rhythm than normal, an abnormality called **Dysdiadochokinesia.**

4. Heel-to-shin test;

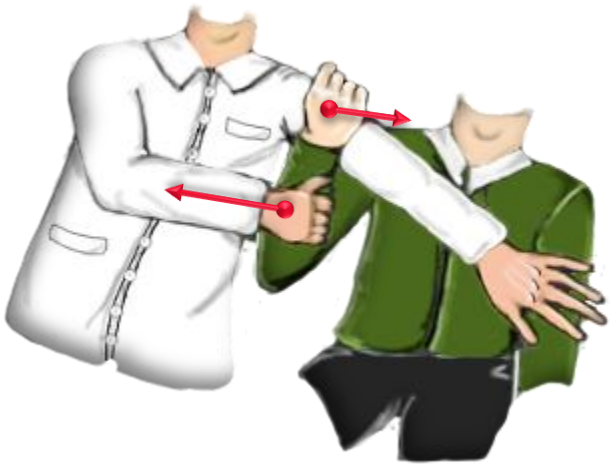
This test can be done either with the patient is setting or supine.

- Ask the patient to lift his heel into the air and to place it on his opposite knee, then slide his heel down and up on his shin between knee and ankle.

5. Rebound phenomenon (of Steven and Holmes);

- Have the patient pulling on your hand and when he does, slip your hand out of his grasp.

Normally, the antagonist muscles will contract and stop hid arm from moving in the desired direction. A +ve sign is seen in spastic limbs where the exaggerated (rebound) response is completely absent causing the limb to continue moving in the desired direction. (be careful that you protect the patient from the unarrested movement causing him to strike himself).



Abnormal results;

The finger-to-nose test;

- May reveal a tendency to fall short of or overshot the examiner's finger (**dysmetria** or **post-pointing**).
- In more severe cases, there is maybe a tremor (or an increase in amplitude of tremor in it is previously present) of the finger as it approaches the target finger and the patient's nose (**kinetic intension or hunting tremor**).
- The movement may be slow, disjointed and clumsy (**dyssynergia**).

- The heel to shin test is the equivalent test for the legs, it is abnormal if the heel wavers away from the line of the shin.
- Weakness may produce false-positive finger-to-nose or heel-to-shin tests, so examine the power first.
- Hypotonia; "Pendular" knee reflex, leg keep swinging after knee jerk (reflex) more than 4 times (4 or less is normal).

Note; The pendulum, is an object suspended from fixed point in the old clocks and it keeps swinging.

Briefly, the symptoms of cerebellar ataxia are;

1. Kinetic intention tremor.
2. Dysmetria.
3. Hypotonia.
4. Decomposition of movement.

Decomposition of movement means; manifestation of cerebellar disease in which a muscular movement is not carried out smoothly but in a series of component motion.

Equilibrium (balance) assessing;

- ✓ Romberg test.
- ✓ Abnormal gait, see page 45.
- ✓ Tandem walking (heel-to-toe), see page 45.
- ✓ Walking on toes and heels.

1. Romberg test;

- Ask the patient to stand up with his feet closed together and his arms down aside.
- Stand behind him and be ready to catch him.
- Ask him to close his eyes.

The human body keeps the balance through 3 systems;

Proprioception (dorsal column)

Vestibular system

Vision

2 of these **3** body balance systems must be functional to maintain body balance.

- When the patient closes his eyes during Romberg test, vision is limited.

- Thus, vestibular system and proprioception must both remain intact to maintain balance.
- If the patient cannot balance after closing his eyes, this may signify that the proprioceptive or the vestibular function has been compromised (deficit).

2. Walking on the heels and tiptoes;

- Ask the patient to walk on his tiptoes for 6 meters away from you then back keeping walking on the heels.
- Having the patient walk on tiptoes will test the planter flexion of the gastrocnemius supplied by the S1 nerve root.
- Having the patient walk on the heels will test the dorsiflexion of the tibialis anterior supplied by the L4 nerve root.

Type of ataxia	Sensory	Cerebellar
Characteristic	The patient loses his balance in the dark or with eyes closed.	The patient is unbalanced, non-coordinated with opened eyes or closed.
Diagnosed by	Romberg test.	Other tests.
Due to	Loss of proprioceptive or vestibular function.	Problem with the cerebellum itself.

NOTES

Glasgow coma scale (GCS);

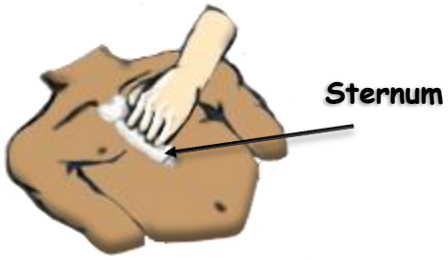
It is used by (first aid and EMT nurses-doctors) around the world to assess the conscious level of acutely ill patients as it is legible to all acute medical and trauma patients.

- The scale uses three main responses;
- Eye response.
- Verbal response.
- Motor response.

And they are based on overall scale of 15 scores.

- Eye response;

- It is based on scale of **4**.
- ✓ **A patient receives a 4** if he spontaneously opens his eyes.
- ✓ **A patient receives a 3** if he only responds to sound.
- ✓ **A patient receives a 2** if he only opens his eyes in response to pain. This can be produced on putting pressure on the nail bed or by sternal rub technique, in which the examiner applies his knuckles of the closed fist to the center of the chest of the patient and rubbing it somewhat hardly to elicit pain response, but not hard enough to do any damage.



- ✓ **A patient receives a 1** if he does not respond at all.

- Verbal response;

- It is based on a scale of **5**.
- ✓ **A patient receives a 5** if he is completely alert. Ask the patient to tell you where he is at the moment and he should answer correctly to get 5.
- ✓ **A patient receives 4** if he is confused when answering but the answer is not coherent and not jumble. When you ask him where he is, he may answer; "at home" or "in the garden" and so on…
- ✓ **A patient receives 3** if his response is only like a word salad with improper words and jumble phrases but not coherent. When you ask him where he is, he may answer you; "smoodle butterfly in chocolate".

✓ **A patient receives a 2** if he produces just incomprehensible sounds like; Ammm…!
✓ **A patient receives a 1** if he has no response at all.

➡ Motor response;

- Based on a scale of **6** scores.

✓ **A patient receives a 6** if he can follow commands, such as; when you ask him to do simple thing like lifting and swinging his hands.
✓ **A patient receives a 5** if he can localize the pain, for example; apply a pressure on the supraorbital notch of the orbit, and observe the movement toward the painful stimulus, i.e; the patient brings hand up beyond chin (purposeful movement).
✓ **A patient receives a 4** if he produces a flexion due to painful stimulus but cannot lift his hand beyond the chin with supraorbital pain. So apply the nail bed pain, he should pull his hand away to get 4.
✓ **A patient receives a 3** if he showed decorticate posture in which;

- The upper limb;

1. Shoulder (rotated internally).
2. Forearms (flexed).
3. Wrist (flexed).
4. Clenched fist.

- The lower limb;

1. Legs (extended & internally rotated).
2. Plantarflexion.

➢ The decorticated posturing also called (abnormal flexor response).
✓ **A patient receives a 2** if he has (decerebrate posturing) also called (abnormal extensor response) in which;

- The upper limb;

1. (adducted) arm.
2. (internal rotation) of shoulders.
3. (extended) elbow.
4. (pronated) forearm.
5. Wrist and fingers (flexion).

- The lower limb;

1. (extended) knee.
2. Planter flexion.

Results of GCS;
✓ From **13-15** indicates mild brain injury.
✓ From **9-12** indicates moderate brain injury.

✓ From **3-8** indicates severe brain injury.

The lowest score the patient can receive is 3 not 0 while the highest is 15.

Summary;

Eye response	Verbal response	Motor response
4*=spontaneous	5*=oriented	6*=obeys commands
3 = to sound	4 = confused	5 = localizing
2 = to pressure	3 = words but not coherent	4 = normal flexion
1* = no response	2 = sounds not words	3 = abnormal flexion
	1* = no response	2 = extension
		1* = no response

The highest score is 15 when the patient gets 4 in eye reflex / 5 in verbal / 6 in motor; (4+5+6=15).

The lowest score is 3 when patient gets 1 in each; (1+1+1=3).

2/ Hoffmann's reflex;

- Place your right index finger under the distal interphalangeal joint of the patient's middle finger.
- Use your right thumb to flick the patient's finger downward.
- Normally, there is absent or slight flexion of the thumb.
- Positive Hoffmann's reflex is called **Hoffmann's sign** and it may indicate UMNL in which the index and thumb fingers flex and get close to each other.

Hoffmann's sign corresponds to the Babinski's sign of the lower limb.

Flicking the middle finger

Positive Hoffmann's sign

3/ Causes of meningeal irritation;

- Meningitis
  - Bacteria
  - Viral
  - Fungal
- Subarachnoid hemorrhage ***(SAH)***
- Sciatica → The inflamed roots of the sciatic nerve cause inflammation of meninges there.

4/ Signs of meningeal irritation;

1. Kernig's sign.
2. Brudzinski's sign.
3. Neck rigidity (stiffness).
4. Opisthotonus.

In general, all the previous signs include pain and problems during the passive movement of certain parts of the body, which stretches the irritated meninges and nerve roots causing pain. The later causes the meninges to induce reflexes which lead to movement limitations and strange responses to passive movement.

- Actually, this is a very acceptable interpretation, and it is improved by this example;
- If you have an injury in your hand, you try to limit the movement of that hand as possible and this is similar to meningeal irritation.

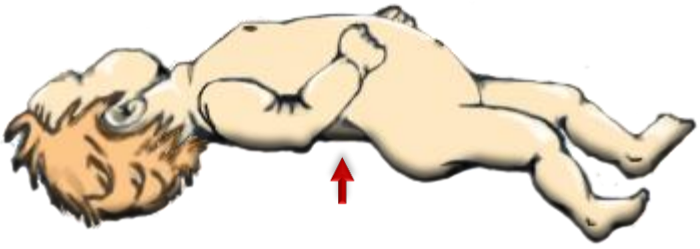
Neck rigidity;

Inability to flex the neck forward due to spasm of the neck muscles.

- It indicates severe meningeal irritation.
- This limits the stretch of meninges by the movement of the spinal cord in the neck area.

Opisthotonus;

Spasm of the whole body that leads to legs and head being bent back and the body bowed forward.



Kernig's sign; (after Waldemer Kernig – a Russian neurologist)

It is positive when the thigh is flexed at hip and the knee is flexed both at 90 degree angles, and subsequent extension in the knee is painful leading to severe stiffness of the hamstring muscles which causes a resistance.

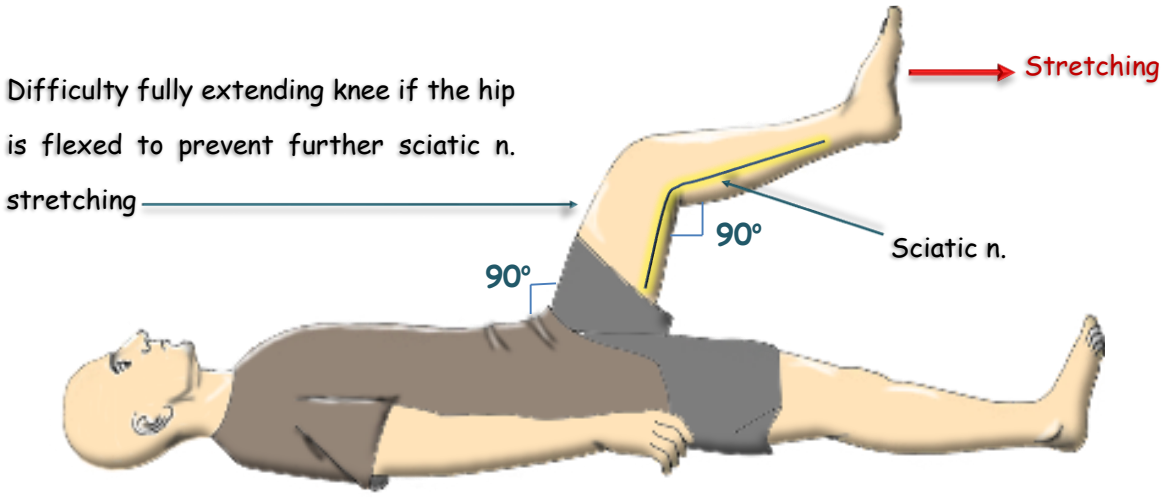
Technique;

- In a quit environment with the patient resting in supine position;
- Have the patient's hip and knee flexed to 90 degrees.
- The knee is then slowly extended by the examiner (repeat on both legs).
- Resistance or pain and inability to extend the patient's knee beyond 135 degrees, because of pain bilaterally indicates a +ve Kernig's sign.
- In severe cases the angle may even remain 90° .

Interpretation;

When the maneuver is performed;

- The pain (spasms) at the hamstring muscles (also; may involve back pain) is a result of stretching the inflamed sciatic nerve roots at angles average between 90 and up to 135, with the popliteal fossa serving as an inner angle.


Difficulty fully extending knee if the hip is flexed to prevent further sciatic n. stretching
Stretching
90°
90°
Sciatic n.

Brudzinski's signs; (after Josef Brudzinski – Polish pediatrics)

They are 4 signs each is tested separately;

1. Brudzinski's neck sign (the most common).
2. The symphyseal sign.
3. The cheek sign.
4. Brudzinski's reflex.

✓ 1/ Brudzinski's sign of neck;

- It is positive when the forced flexion of the neck elicits a reflex flexion of the thigh (LL), with the patient lying supine.

Technique;

- In a quiet environment with the patient resting in a supine position;
- Gently grasp the patient's head from behind and place the other hand on the patient's chest.
- Gently raise the neck, bringing chin to chest.
- Positive sign is involuntary flexing of the hips and knees.

Interpretation;

It is theorized that in meningitis passive flexion of the neck stretched the nerve roots through the meninges, both of which are inflamed causing pain and involuntary movement of lower extremities to lessen the stretch on the inflamed meninges.

✓ **2/ The cheek sign (it is obscure);**

- A positive cheek sign is elicited by placing pressure on both cheeks inferior arch causing spontaneous flexion of the forearm and arm.

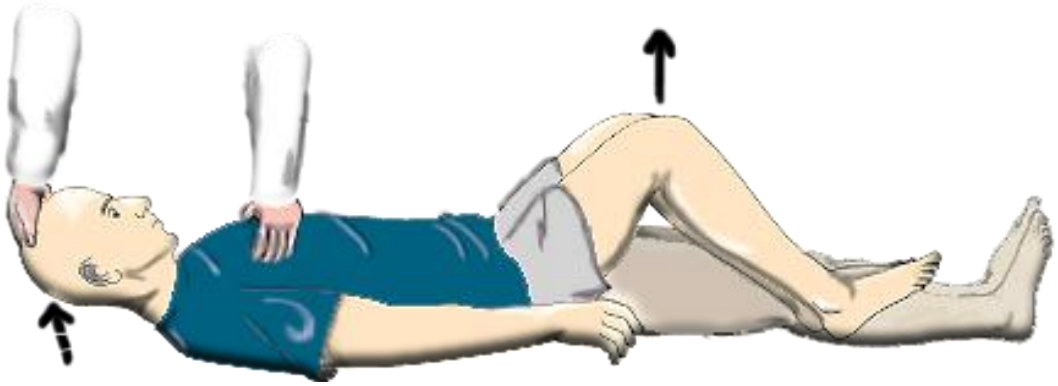
✓ **3/ The symphyseal sign;**

- A positive symphyseal sign occurs when pressure is applied to the pubic symphysis elicits as reflex hip and knee flexion, and abduction of legs.

Both of these signs (2+3) were most commonly observed in children with meningitis caused by Mycobacterium tuberculosis.

✓ **4/ Brudzinski's reflex;**

- Passive flexion of one knee into the abdomen eliciting flexion of the opposite hip and knee.



Neck flexion causes knee and hip flexion

(Brudzinski's sign and test)